SOIL SURVEY OF

Harvey County, Kansas

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

Issued November 1974

Major fieldwork for this soil survey was done in the period 1963–69. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1969. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Harvey County Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Harvey County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification, range site classification, and windbreak group classification of each. It also shows the page where each soil is described and the page for the description of the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the interpretative groupings.

Foresters and others can refer to the section "Management of Windbreaks," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others concerned with wildlife will find information useful in the management of wildlife habitat in the section "Fish and Wildlife."

Ranchers and others interested in range can find, under "Management of Range," groupings of the soils according to their suitability for range and also the names of many of the plants that grow on each range site.

Engineers and builders will find, under "Engineering Uses of the Soils," tables that give estimates of the engineering properties of the soils in the county and interpretations of these properties as they affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the "Soils."

Newcomers in Harvey County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Facts About the County," which gives additional information about the county.

Cover: **Limy Upland range site in good condition. Native vegetation has been mowed and baled to be used for winter feed. Big bluestem, little bluestem, indiangrass, and switchgrass are the dominant grasses. Soil is Clime silty clay.**

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Issued November 1974

SOIL SURVEY OF HARVEY COUNTY, KANSAS

BY BRUCE R. HOFFMAN AND LOUIE W. DOWD, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE KANSAS AGRICULTURAL EXPERIMENT STATION

HARVEY COUNTY, located in the south-central part of Kansas (fig. 1), has an area of 345,600 acres, or 540 square miles. In 1960 the population was 25,775. Of this number, 14,958 lived in Newton, the county seat.

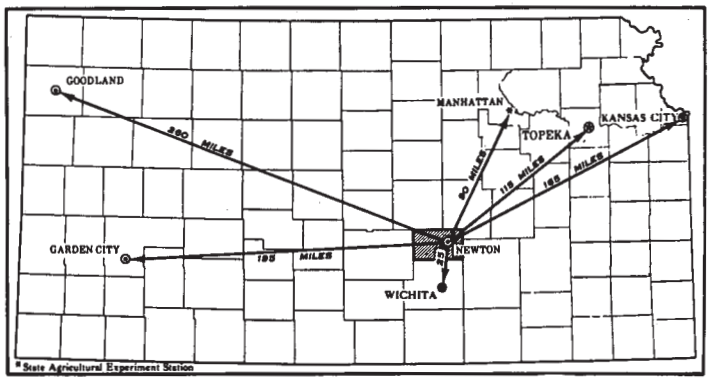

Figure 1.—**Location of Harvey County in Kansas.**

Most soils in the county are suitable for cultivation. The Conservation Needs Inventory of 1966 shows that 257,657 acres were used for crops. Wheat was grown on about 113,000 acres and sorghum on about 53,000 acres in that year, according to figures of the Kansas State Board of Agriculture. Less common crops are alfalfa, corn, soybeans, barley, rye, and oats.

Rangeland accounted for 64,000 acres in 1966. It is concentrated in the sandhills north of Burrton and in the eastern part of the county. Small pastures are scattered throughout the county.

The farm income of the county is derived mainly from the sale of wheat, grain sorghum, and livestock. A survey by the Extension Service in 1962 showed that about 24 percent of the farm operators reported income from work away from the farm.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Harvey County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and nature of streams; the kinds of crops and native plants; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Pratt and Goessel, for example, are the names of two soil series. All the soils in the United States that have the same series name are essentially alike in natural characteristics.

Soils of one series can differ in texture of the surface and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Goessel silty clay, 1 to 2 percent slopes, is one of two phases of the Goessel series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and similar details that greatly help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit, the soil complex, is shown on the soil map of Harvey County.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Dillwyn-Plevna complex is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Alluvial land, broken, is a land type in this county.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Harvey County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another association, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The textures named in the descriptive legends of the associations are those of the surface layer of the dominant soils. In association 1, for example, the Crete soils have a surface layer of silt loam and the Ladysmith soils have a surface layer of silty clay loam.

The names of some soil associations are unlike those that appear in recently published surveys of adjacent counties. These differences result from changes in concepts of soil series in the application of the soil classification system.

The soil associations in Harvey County are described on the following pages.

1. Crete-Ladysmith association

Deep, nearly level to gently sloping, moderately well drained silt loams and silty clay loams on uplands

Association 1 is in the western part of the county on broad ridges and side slopes. It occupies about 13 percent of the county. About 50 percent of the association is Crete soils, about 20 percent is Ladysmith soils, and about 30 percent is Smolan, Farnum, Hobbs, and Detroit soils (fig. 2).

Crete soils are nearly level to gently sloping and are moderately well drained. They have a surface layer of silt loam about 11 inches thick. The upper 6 inches of the subsoil is silty clay loam. The lower part of the subsoil is silty clay that is not easily penetrated by roots, water, and air.

Ladysmith soils are nearly level and moderately well drained. They have a surface layer of silty clay loam about 10 inches thick. The subsoil is silty clay, and the lower part is not easily penetrated by roots, water, and air.

Smolan, Farnum, Hobbs, and Detroit soils are less extensive in the association. Smolan and Farnum soils are on slopes below Crete and Ladysmith soils. Hobbs and Detroit soils are nearly level and are on flood plains and low terraces.

About 90 percent of this association is in crops. Small areas of native grass are scattered throughout the association. Wheat and sorghum are the main crops; some alfalfa is grown. Fertility is medium to high, and the available water capacity is high.

Water erosion is the main hazard on the sloping soils. Maintenance of tilth is the main limitation on the nearly level soils.

The nearly level soils of this association are suitable for flood irrigation. A few areas have been leveled. Sorghum and corn are the main irrigated crops; soybeans are irrigated to a lesser extent.

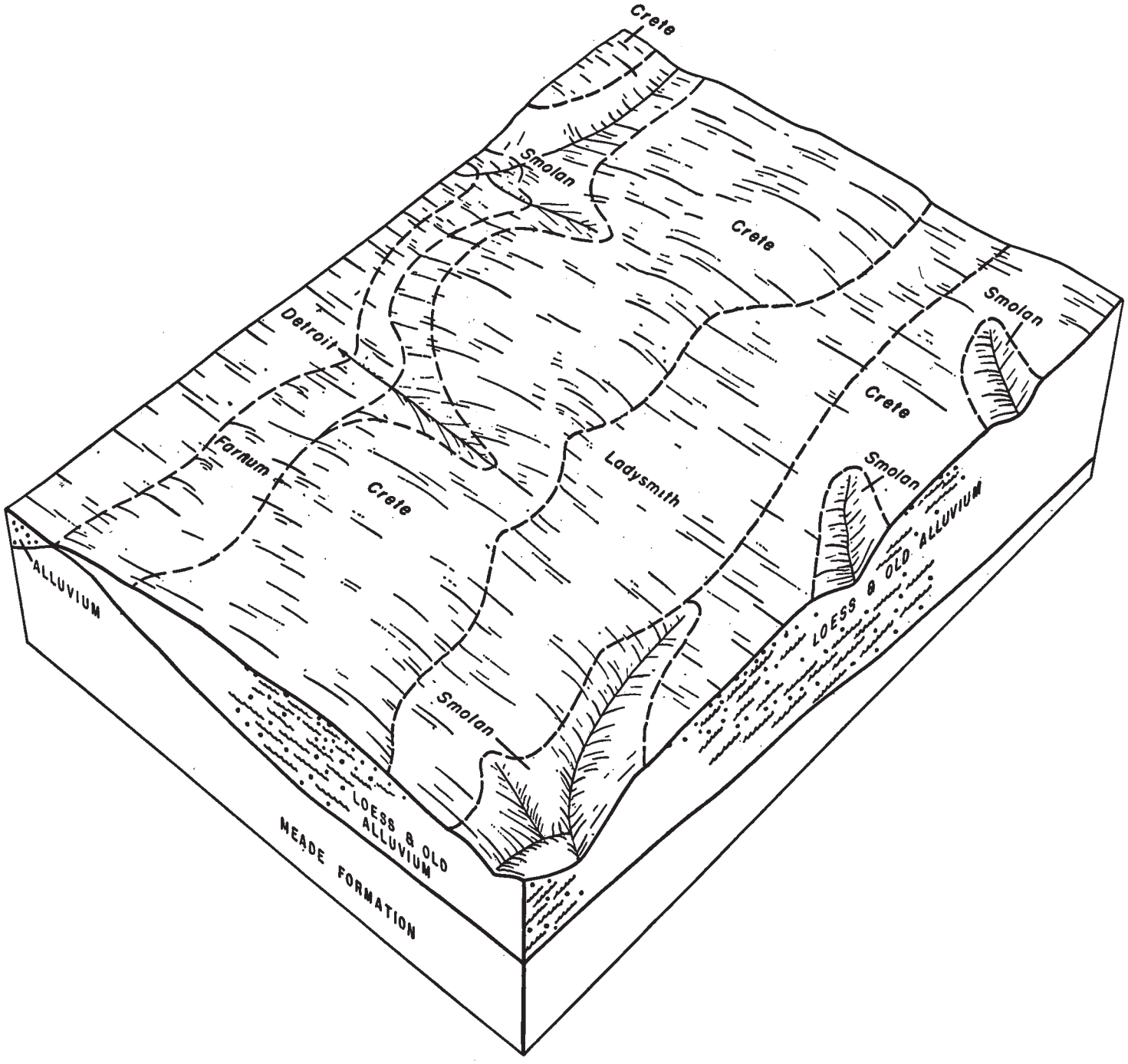

***Figure 2.*—Typical pattern of soils in the Crete-Ladysmith association.**

2. *Dillwyn-Tivoli association*

Deep, nearly level, somewhat poorly drained loamy fine sands and deep, hummocky, excessively drained fine sands on uplands

Association 2 is in the western part of the county in the sandhills north of Burrton. It is in a nearly level to hummocky area where soil patterns are complex (fig. 3). It occupies about 4 percent of the county. About 35 percent of the association is Dillwyn soils, about 30 percent is Tivoli soils, and about 35 percent is Plevna, Pratt, and Carwile soils.

Dillwyn soils are nearly level and somewhat poorly drained. They are loamy fine sand throughout and are easily penetrated by roots, water, and air. The surface layer is about 8 inches thick and contains a slight accumulation of organic matter. The water table is within 5 feet of the surface. Dillwyn soils are intermingled with Tivoli and Plevna soils.

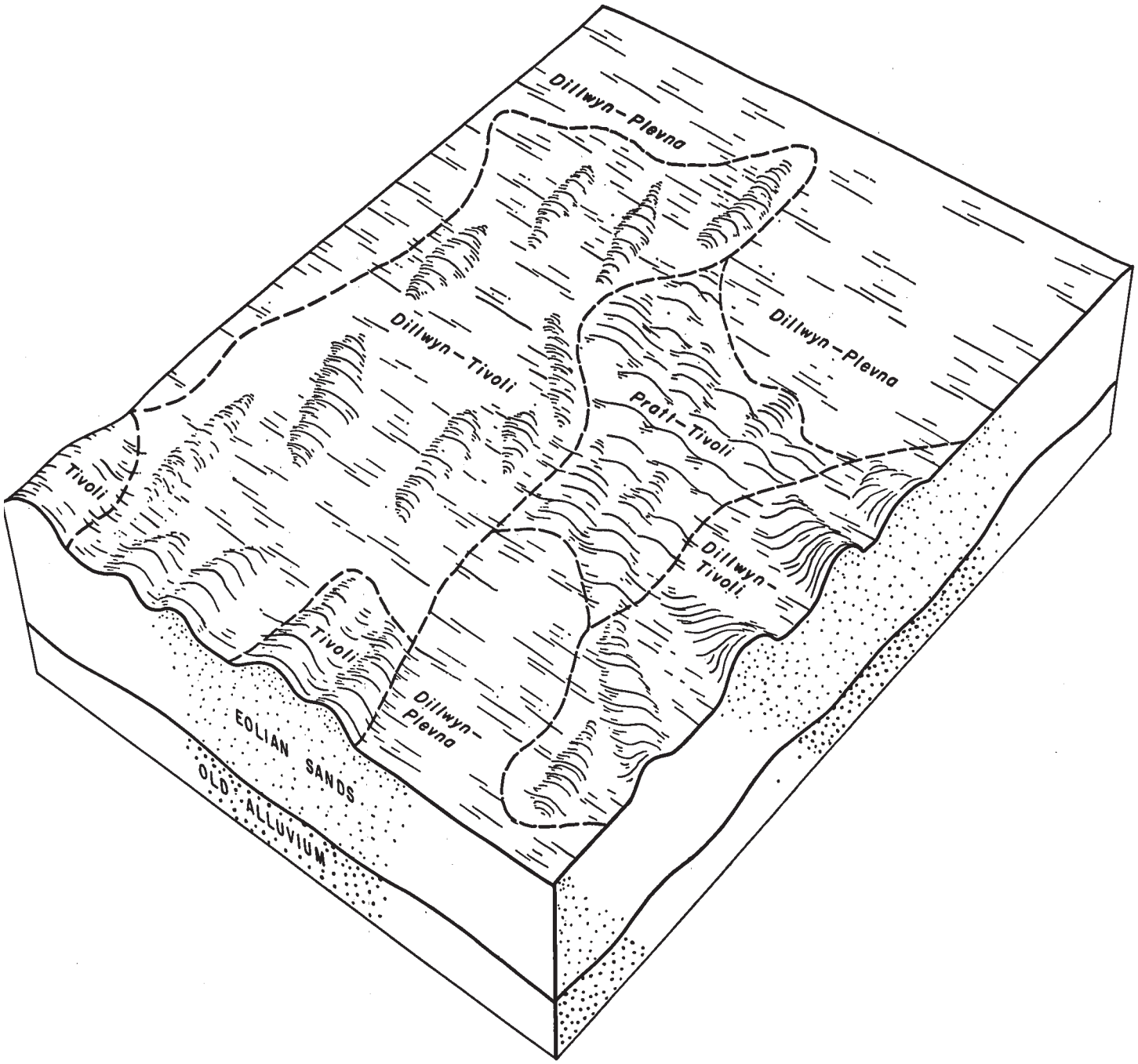

***Figure 3.*—Typical pattern of soils in the Dillwyn-Tivoli association.**

Tivoli soils are on hummocks and dunes and are excessively drained. They have a fine sand or loamy fine sand surface layer, about 7 inches thick, that contains a slight accumulation of organic matter. The underlying material is fine sand that is easily penetrated by roots, water, and air. Tivoli soils are intermingled with Dillwyn and Pratt soils in most areas where they are mapped in Harvey County.

Plevna, Pratt, and Carwile soils are less extensive in the association. Plevna and Carwile soils are nearly level. Pratt soils are undulating.

Most of this association is in native grass. The soils are well suited to grass, but careful management is needed. Fertility and available water capacity are low. Dillwyn and Plevna soils produce an especially large amount of forage because they have a high water table.

The soils of this association absorb most precipitation that falls, and no drainage pattern has been established. The surface layer is sandy and is subject to blowing unless protected by a cover of plants.

3. *Carwile-Pratt association*

Deep, nearly level, somewhat poorly drained fine sandy loams and deep, undulating, well-drained loamy fine sands on uplands

Association 3 is in four areas in the central and western parts of the county. It occupies about 7 percent of the county. About 45 percent of the association is Carwile soils, about 25 percent is Pratt soils, and about 30 percent is Crete, Farnum, Ladysmith, Naron, and Geary soils.

Carwile soils are nearly level and somewhat poorly drained. These soils have a surface layer of fine sandy loam about 10 inches thick. The upper 8 inches of the subsoil is fine sandy loam. The lower part of the subsoil is clay or clay loam that is not easily penetrated by roots, water, and air.

Pratt soils are undulating and well drained. These soils are loamy fine sand throughout and are easily penetrated by roots, water, and air.

Crete, Farnum, Ladysmith, Naron, and Geary soils are less extensive in the association. These nearly level and gently sloping soils are moderately well drained and well drained.

Most of this association is used for wheat and sorghum, but a small part is in native grass. The soils are easy to work. Fertility is low to medium, and the available water capacity is low to moderate.

Soil blowing is a serious hazard where the soils are not adequately protected by crop residue or plants.

No drainage pattern has been established. Water ponds in places on the Carwile soils, and planting and harvesting are delayed in some years.

4. *Farnum-Slickspots-Naron association*

Deep, nearly level to gently sloping, well-drained to somewhat poorly drained loams and fine sandy loams on uplands

Association 4 is in the southwestern part of the county. It occupies about 10 percent of the county. About 60 percent of the association is Farnum soils, about 15 percent is Slickspots, about 10 percent is Naron soils, and about 15 percent is Drummond, Carwile, and Ladysmith soils.

Farnum soils are nearly level and well drained. These soils have a surface layer of loam or fine sandy loam about 14 inches thick. The upper part of the subsoil is clay loam, and the lower part is sandy clay loam. Roots, water, and air are somewhat restricted in their penetration of these soils.

The Slickspots part of the association is nearly level and is intermingled with Farnum soils. It has a loamy surface layer and a clayey subsoil that has concentrations of soluble salts.

Naron soils are nearly level to gently sloping and are well drained. These soils have a surface layer of fine sandy loam about 10 inches thick. The subsoil is fine sandy loam or sandy clay loam that is easily penetrated by roots, water, and air.

Drummond, Carwile, and Ladysmith soils are less extensive in the association. These soils are nearly level and moderately well drained or somewhat poorly drained.

Most of this association is used for wheat and sorghum. A smaller amount of alfalfa is grown. The areas more severely affected by salt are mostly in native grass. Fertility is low to high, and the available water capacity is moderate to high.

The most serious limitation is in the salt-affected soils, which are difficult to till and form surface crusts after rain. These soils are mainly intermingled with soils that are not affected by salt. Soil blowing is a moderate hazard on soils that have a surface layer of fine sandy loam.

The soils of this association that are not affected by salt are suitable for irrigation. Local pockets of gravel occur.

5. *Detroit-Hobbs association*

Deep, nearly level, moderately well drained to well drained silty clay loams and silt loams on flood plains

Association 5 is along the Little Arkansas River, Turkey Creek, the lower parts of Sand and Black Kettle Creeks, and in the southwestern corner of the county. It occupies about 6 percent of the county. About 45 percent of the association is Detroit soils, about 25 percent is Hobbs soils, and about 30 percent is Ladysmith, Naron, Farnum, and Lesho soils and Slickspots and Alluvial land, broken.

Detroit soils are nearly level and moderately well drained. These soils have a surface layer of silty clay loam about 11 inches thick. The subsoil is silty clay loam or silty clay. Water and air are somewhat restricted in their penetration of these soils. Flooding is a hazard.

Hobbs soils are nearly level and well drained. These soils are silt loam or silty clay loam throughout and are easily penetrated by roots, water, and air. Hobbs soils are closer to the stream than Detroit soils in most areas. Flooding is a hazard.

Ladysmith, Naron, Farnum, and Lesho soils; Slickspots; and Alluvial land, broken, are less extensive in the association. Alluvial land, broken, is along streams and streambanks. Nearly level Ladysmith soils and Slickspots are intermingled. Naron and Farnum soils are mainly along the Little Arkansas River above Halstead and in the southwestern corner of the county. The Lesho soils are nearly level and somewhat poorly drained.

Almost all of this association except Alluvial land, broken, is cropland. The main crops are wheat and sorghum. Fertility is high, and the available water capacity is high.

Flooding is the main hazard. It varies from year to year in intensity and duration. Soil blowing is a minor hazard on the Naron and Farnum soils. Maintenance of tilth is a limitation on the Ladysmith soils and Slickspots. Alluvial land, broken, is too steep for cultivation.

Many areas of this association are suitable for irrigation.

6. *Ladysmith-Goessel association*

Deep, nearly level to gently sloping, moderately well drained silty clay loams and silty clays on uplands

Association 6 is on broad divides between the major streams (fig. 4). It is the most extensive association, and it occupies about 30 percent of the county.

About 80 percent of the association is Ladysmith soils, about 15 percent is Goessel soils, and about 5 percent is Farnum and Naron soils and Breaks-Alluvial land complex.

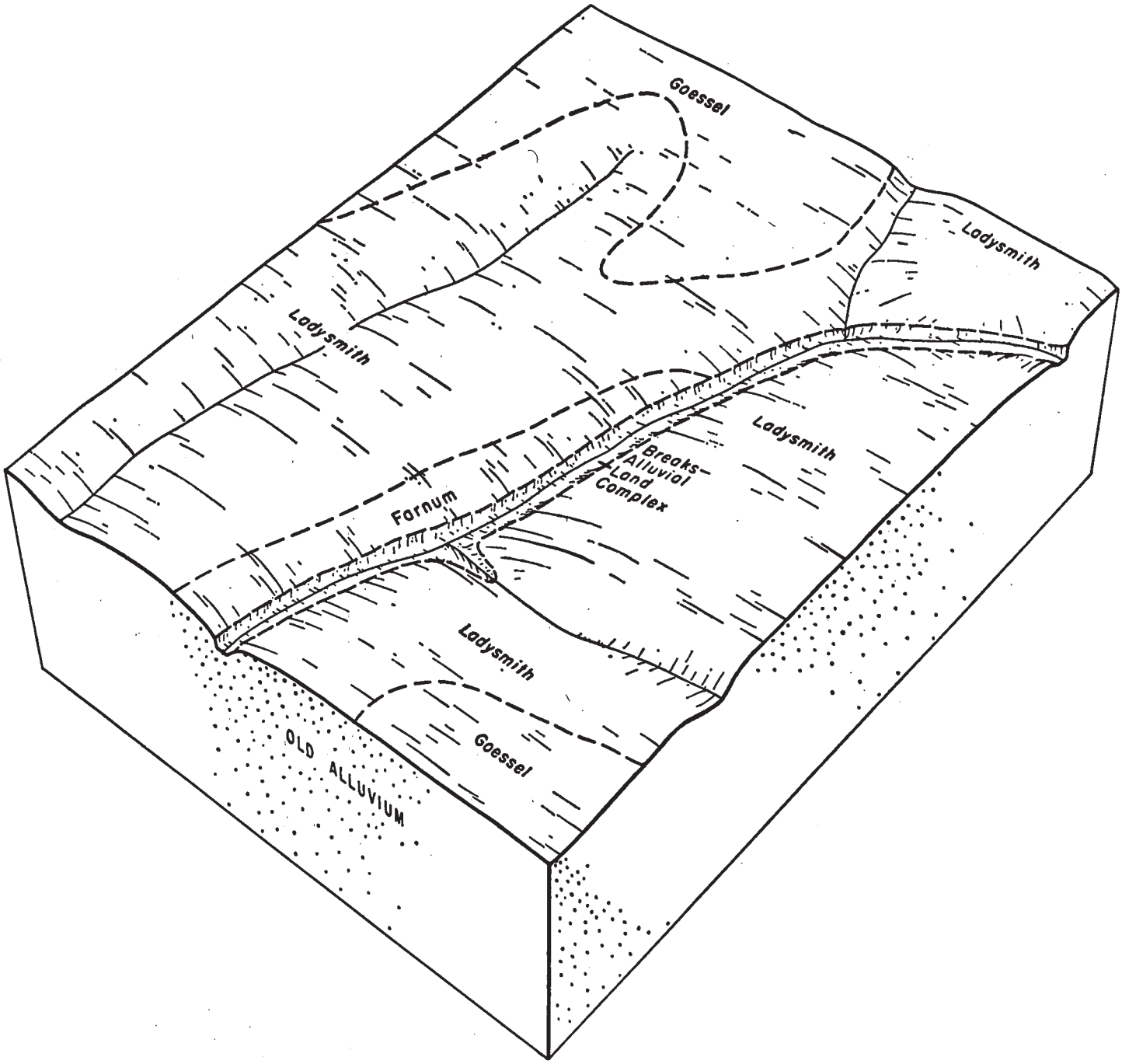

Figure 4. **Typical pattern of soils in the Ladysmith-Goessel association.**

Ladysmith soils are nearly level to gently sloping and are moderately well drained. They have a surface layer of silty clay loam about 10 inches thick. The subsoil is silty clay that is not easily penetrated by roots, water, and air.

Goessel soils are nearly level to gently sloping and are moderately well drained. They are silty clay throughout and are not easily penetrated by roots, water, and air.

Farnum and Naron soils and Breaks-Alluvial land complex are less extensive in the association. Farnum soils are nearly level to gently sloping and are well drained. They are below areas of Ladysmith soils. Naron soils are gently sloping and below areas of Farnum soils. Breaks-Alluvial land complex is along some drainageways.

Most of this association is used for wheat and sorghum. A smaller amount is in alfalfa. A few small areas of range are scattered throughout the association. The Ladysmith and Goessel soils have medium fertility and high available water capacity.

Water erosion is a serious hazard on the gently sloping soils. Some nearly level soils need surface drainage during years of more than average rainfall.

7. *Farnum-Hobbs-Geary association*

Deep, nearly level to gently sloping, well-drained loams and silt loams on uplands and flood plains

Association 7 is along streams in the central and eastern parts of the county. It occupies about 10 percent of the county. About 40 percent of the association is Farnum soils, about 30 percent is Hobbs soils, about 15 percent is Geary soils, and about 15 percent is Kaski, Smolan, Clark, and Naron soils and Alluvial land, broken.

Farnum soils are well drained. Most of these soils are gently sloping, but a small amount is moderately sloping. They have a surface layer of loam about 14 inches thick. The upper part of the subsoil is clay loam, and the lower part is sandy clay loam. Roots, water, and air are somewhat restricted in their penetration of these soils.

Hobbs soils are nearly level and well drained but are subject to flooding. These soils are silt loam or silty clay loam throughout and are easily penetrated by roots, water, and air. They are on flood plains below areas of Farnum and Geary soils.

Geary soils are gently sloping and well drained. These soils have a surface layer of silt loam about 9 inches thick. The subsoil is silty clay loam in the upper part and clay loam in the lower part and is easily penetrated by roots, water, and air. Most Geary soils are along Emma Creek and Sand Creek.

Kaski, Smolan, Clark, and Naron soils and Alluvial land, broken, are less extensive in the association. Kaski soils are nearly level and well-drained soils on flood plains. Smolan, Clark, and Naron soils are gently sloping and well drained. Alluvial land, broken, is along streams and streambanks.

Most of this association is in crops. Wheat and sorghum are the main crops. Areas of range are mostly along the streams.

Water erosion and flooding are the major hazards. The Farnum, Geary, Smolan, Clark, and Naron soils are subject to water erosion. The Hobbs and Kaski soils are subject to occasional to frequent flooding.

8. *Irwin-Rosehill-Clime association*

Deep and moderately deep, gently sloping to sloping, well-drained silty clay loams and silty clays on uplands

Association 8 is in the eastern part of the county. It occupies about 20 percent of the county. About 35 percent of the association is Irwin soils, about 30 percent is Rosehill soils, about 25 percent is Clime soils, and about 10 percent is Hobbs, Ladysmith, and Goessel soils and Breaks-Alluvial land complex (fig. 5).

Irwin soils are deep, gently sloping to moderately sloping, and well drained. These soils have a surface layer of silty clay loam about 11 inches thick and a subsoil of silty clay. Irwin soils are on the highest areas.

Rosehill soils are moderately deep over shale and are well drained. These soils are silty clay above the shale. In most places they are below areas of Irwin soils and above areas of Clime soils.

Clime soils are moderately deep over shale and are well drained. These soils are silty clay above the shale. In most places Clime soils are calcareous throughout, but in some places the upper 10 inches is noncalcareous.

Hobbs, Ladysmith, and Goessel soils and Breaks-Alluvial land complex are less extensive in the association. Hobbs soils are nearly level and well drained. They are on flood plains. Ladysmith and Goessel soils are on ridges. Breaks-Alluvial land complex is along intermittent drainageways.

About 60 percent of this association is used for crops, and the rest of the acreage is in native grass. Wheat and sorghum are the main crops. The soils are not easily penetrated by roots, water, and air. Fertility is medium. The Irwin soils have high available water capacity, and the Clime and Rosehill soils have low available water capacity.

Water erosion is the main hazard. If these soils are well managed, they are well suited to grazing.

Descriptions of the Soils

This section describes the soil series and mapping units in Harvey County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative of mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, unless they are differences that are apparent from the name of the mapping unit. Color terms are for dry soil unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Alluvial land, broken, for example, does not belong to a soil series, but nevertheless it is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of the description of each mapping unit are the capability unit, the range site, and the windbreak group in which the mapping unit has been placed. The page on which the range site is described can be learned by referring to the "Guide to Mapping Units" at the back of this survey. A listing in which the capability units are briefly described is given under the heading "Capability Grouping." Discussions of use and management of the soils for field crops and pasture are included in the descriptions of the soils. Windbreak groups are described under the heading "Management of Windbreaks."

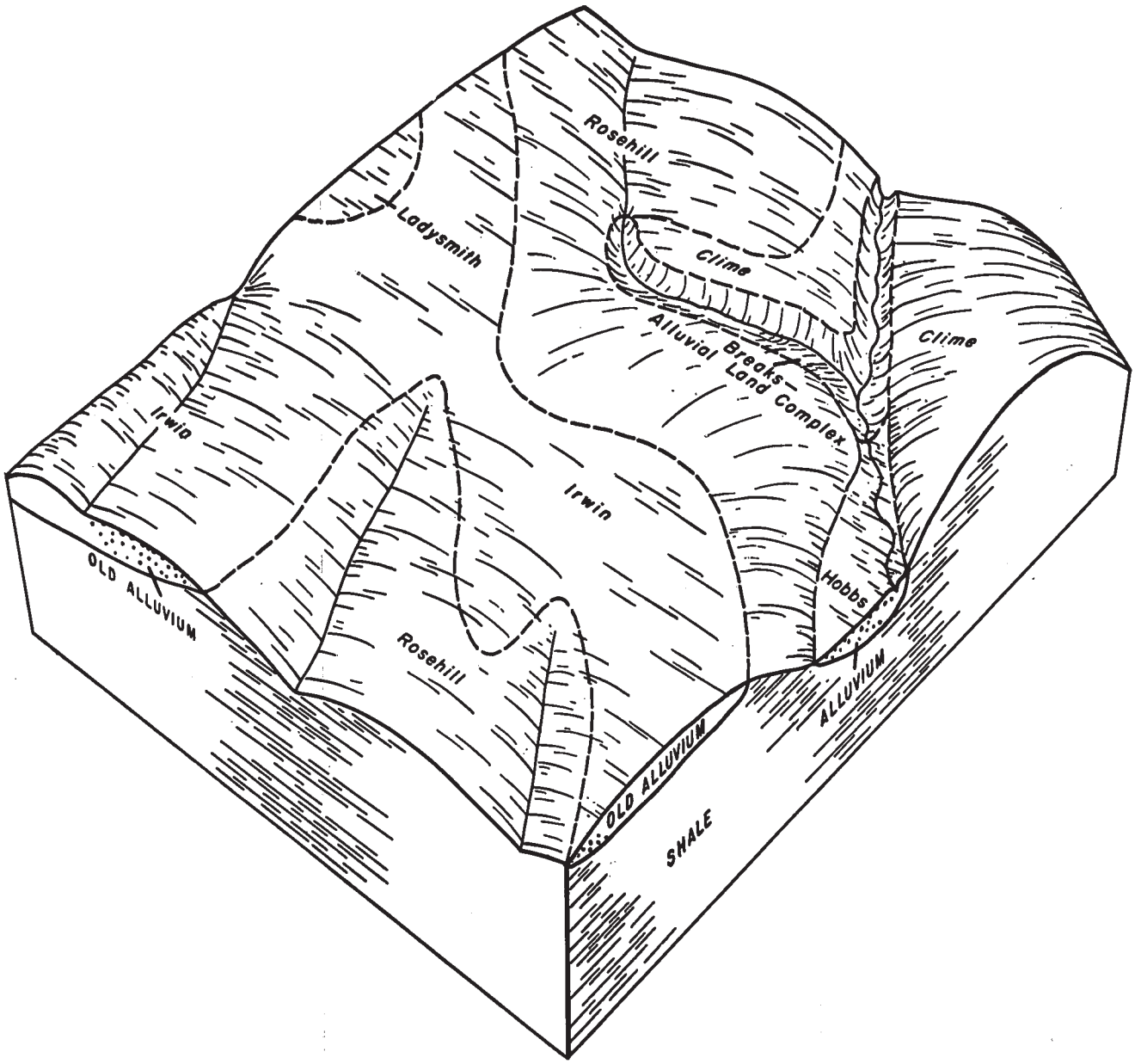

Figure 5.—**Typical pattern of soils in the Irwin-Rosehill-Clime association.**

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary. More detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*5*).[1]

Alluvial Land, Broken

Alluvial land, broken (Ad) consists of deeply entrenched stream channels that have steep, broken sides. The areas are 75 to 300 feet wide. Soils on the sides are similar to adjoining soils. The texture ranges from fine sandy loam to silty clay loam. Slopes range from 0 to 20 percent. A significant part of this mapping unit is flooded during time of high streamflow.

This land type is not suitable for cultivation and has little value for grazing. Most areas are used for range; some are idle. The vegetation is mostly trees and shrubs and some tall grasses. Capability unit VIIw–1; not in a range site or windbreak group.

Breaks-Alluvial Land Complex

Breaks-Alluvial land complex (Ba) consists of the sloping to steep sides and the nearly level, narrow bottoms of intermittent drainageways. The areas are 75 to 300 feet wide. Slopes range from 0 to 20 percent.

[1] Italic numbers in parentheses refer to Literature Cited, p. 52.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent
	Acres	*Percent*
Alluvial land, broken	3,887	1.1
Breaks-Alluvial land complex	4,599	1.3
Carwile fine sandy loam	11,489	3.3
Clark clay loam, 1 to 3 percent slopes	424	.1
Clime silty clay, 1 to 3 percent slopes	5,762	1.7
Clime silty clay, 3 to 6 percent slopes	4,971	1.4
Clime silty clay, 2 to 6 percent slopes, eroded	2,138	.6
Clime complex, 6 to 12 percent slopes	2,698	.8
Crete silt loam, 0 to 1 percent slopes	14,459	4.2
Crete silt loam, 1 to 3 percent slopes	9,463	2.8
Detroit silty clay loam	11,776	3.4
Dillwyn-Plevna complex	3,938	1.1
Dillwyn-Tivoli complex	5,015	1.5
Drummond complex	3,075	.9
Farnum fine sandy loam, 0 to 1 percent slopes	3,648	1.1
Farnum loam, 0 to 1 percent slopes	10,068	2.9
Farnum loam, 1 to 3 percent slopes	20,208	5.8
Farnum loam, 3 to 6 percent slopes	1,068	.3
Farnum-Slickspots complex	16,993	4.9
Geary silt loam, 0 to 1 percent slopes	1,068	.3
Geary silt loam, 1 to 3 percent slopes	6,205	1.8
Geary silt loam, 3 to 6 percent slopes	2,310	.7
Goessel silty clay, 0 to 1 percent slopes	10,935	3.2
Goessel silty clay, 1 to 2 percent slopes	2,089	.6
Hobbs silt loam	17,292	5.0
Irwin silty clay loam, 1 to 3 percent slopes	22,929	6.6
Irwin silty clay loam, 3 to 6 percent slopes	2,173	.6
Irwin silty clay loam, 2 to 6 percent slopes, eroded	379	.1
Kaski loam	1,027	.3
Ladysmith silty clay loam, 0 to 1 percent slopes	47,419	13.7
Ladysmith silty clay loam, 1 to 2 percent slopes	34,977	10.1
Ladysmith-Slickspots complex	4,695	1.4
Lesho loam	386	.1
Naron fine sandy loam, 0 to 1 percent slopes	5,836	1.7
Naron fine sandy loam, 1 to 4 percent slopes	5,579	1.6
Pratt loamy fine sand, 1 to 5 percent slopes	3,153	.9
Pratt-Carwile complex	4,779	1.4
Pratt-Tivoli loamy fine sands	3,380	1.0
Rosehill silty clay, 1 to 3 percent slopes	16,499	4.8
Rosehill silty clay, 3 to 6 percent slopes	4,872	1.4
Smolan silty clay loam, 1 to 3 percent slopes	9,911	2.9
Tivoli fine sand	982	.3
Water	550	.2
Intermittent lakes	319	.1
Gravel pits	98	(1)
Borrow pits	79	(1)
Total	345,600	100.0

[1] Less than 0.05 percent.

Breaks make up about 70 percent of the mapping unit. These areas are dominantly moderately deep and shallow silty clay underlain by Permian shale. Less extensive are deep soils that have a subsoil of clay loam to silty clay. The soils on sides of drainageways dominantly have slopes of 6 to 20 percent.

Alluvial land makes up about 30 percent of the complex. It is nearly level except for a shallow, meandering stream channel. The soils of this part of the complex are silt loam or silty clay loam throughout.

This complex is well suited to range and wildlife habitat and is used mainly for these purposes. If properly managed, it supports good stands of native grass. Breaks are too steep for cultivation. Capability unit VIe–3; Breaks part in Clay Upland range site; Alluvial land part in Loamy Lowland range site; not in a windbreak group.

Carwile Series

The Carwile series consists of deep, somewhat poorly drained, level or depressional soils on uplands. These soils formed in old clayey alluvium and loamy eolian material.

In a representative profile the surface layer is grayish-brown fine sandy loam 10 inches thick. The subsoil is 27 inches thick. The upper 8 inches is gray, friable fine sandy loam. The middle 10 inches is gray, mottled, extremely firm clay. The lower 9 inches is light brownish-gray, mottled, very firm clay loam. The underlying material is light-gray, mottled clay loam.

Runoff is slow, and much rainwater soaks into the soil. Permeability is slow, the available water capacity is moderate, and fertility is medium.

Representative profile of Carwile fine sandy loam in a cultivated field, 2,600 feet east and 100 feet south of the northwest corner of sec. 24, T. 23 S., R. 3 W.

A1—0 to 10 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable; medium acid; clear, smooth boundary.

B1—10 to 18 inches, gray (10YR 5/1) heavy fine sandy loam, very dark gray (10YR 3/1) moist; weak, medium, subangular blocky structure; hard, friable; slightly acid; clear, smooth boundary.

B21t—18 to 28 inches, gray (10YR 5/1) light clay, very dark gray (10YR 3/1) moist; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, blocky structure; extremely hard, extremely firm; neutral; gradual, smooth boundary.

B22t—28 to 37 inches, light brownish-gray (10YR 6/2) heavy clay loam, grayish brown (10YR 5/2) moist; common, medium, distinct, light yellowish-brown (2.5Y 6/4) mottles; moderate, medium, blocky structure; very hard, very firm; mildly alkaline; gradual, smooth boundary.

C—37 to 60 inches, light-gray (10YR 7/2) clay loam, light brownish gray (10YR 6/2) moist; common, medium, distinct, yellowish-red (5YR 5/6) and light yellowish-brown (2.5Y 6/4) mottles; massive; hard, firm; mildly alkaline.

The A horizon ranges from 6 to 14 inches in thickness. It ranges from very dark gray to grayish brown and from medium acid to slightly acid. In some places there is an Ap horizon of loamy fine sand. The B1 horizon ranges from fine sandy loam to clay loam. The B2t horizon is clay loam or clay; it is 35 to 48 percent clay. It ranges from dark gray to light brownish gray and from slightly acid to mildly alkaline. Mottles are distinct or prominent. In some places calcareous concretions are below a depth of 30 inches.

Carwile soils are associated with Farnum and Ladysmith soils. They have a more clayey B2t horizon than Farnum soils. They differ from Ladysmith soils in having mottles in the B21t horizon.

Carwile fine sandy loam (0 to 1 percent slopes) (Ca).—This soil is in low areas or slight depressions.

Included areas of Pratt loamy fine sand make up about 10 percent of this soil, areas of Farnum fine sandy loam about 5 percent, and areas of Naron fine sandy loam about 3 percent. These inclusions are on higher, convex areas.

This Carwile soil is easily tilled. Excessive wetness is a moderate hazard. This soil is saturated with water at

some time during most years. Surface drainage is needed in some places. During wet weather, water is sometimes ponded on the surface for several days. Planting and harvesting are often delayed, and crops are drowned out in some years. Soil blowing is a slight hazard if the surface is bare of vegetation. Blowing can be controlled by wind stripcropping, stubble mulching, and field windbreaks. Incorporating crop residue into the soil improves water penetration and fertility.

This soil is well suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. This soil is suitable for irrigation if adequate drainage is provided. Capability unit IIw–2; Sandy range site; windbreak group 3.

Clark Series

The Clark series consists of deep, well-drained, gently sloping, calcareous soils on uplands. These soils formed in highly calcareous, loamy old alluvium.

In a representative profile the surface layer is clay loam 10 inches thick. The upper 6 inches is a dark-gray plow layer, and the lower 4 inches is very dark gray. The next layer is 6 inches thick. It is friable clay loam that is about 20 percent hard and soft masses of lime. It has mixed colors of grayish brown and dark gray. The underlying material is pale-brown clay loam that is about 35 percent hard and soft masses of lime.

Runoff is medium, and permeability is moderate. Fertility is medium. The available water capacity is high.

Representative profile of Clark clay loam, 1 to 3 percent slopes, in a cultivated field, 900 feet west and 85 feet north of the southeast corner of the SW¼ sec. 27, T. 22 S., R. 1 W.

Ap—0 to 6 inches, dark-gray (10YR 4/1) light clay loam that is nearly silty clay loam, very dark gray (10YR 3/1) moist; moderate, medium, granular structure; slightly hard, friable; calcareous, mildly alkaline; clear, smooth boundary.

A1—6 to 10 inches, very dark gray (10YR 3/1) clay loam that is nearly silty clay loam, black (10YR 2/1) moist; moderate, medium, granular structure; hard, friable; calcareous, mildly alkaline; clear, smooth boundary.

AC—10 to 16 inches, grayish-brown (10YR 5/2) and dark-gray (10YR 4/1) clay loam, dark grayish brown (10YR 4/2) and very dark gray (10YR 3/1) moist; moderate, medium, granular structure; hard, friable; few sand grains; calcareous (about 20 percent hard and soft masses of lime), moderately alkaline; gradual, smooth boundary.

C—16 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; weak, medium, granular structure; hard, friable; calcareous (about 35 percent hard and soft masses of lime), moderately alkaline.

The A horizon ranges from 6 to 14 inches in thickness and from very dark gray to grayish brown in color. It is loam in some places. In some areas the upper 6 inches of soil is noncalcareous. The C horizon ranges from grayish brown, brown, or yellowish brown to white, very pale brown, pinkish white, or pink. It is more than 20 percent calcium carbonate.

The temperature of Clark soils mapped in this county in areas north and east of the Little Arkansas River is cooler than is defined in the range for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Clark soils are associated with Ladysmith and Kaski soils. Clark soils are less clayey than Ladysmith soils and contain more calcium carbonate. They contain more calcium carbonate than Kaski soils.

Clark clay loam, 1 to 3 percent slopes (Cc).—This soil is on uplands. Slopes are convex.

Included concave areas of Farnum loam make up 3 percent of the acreage of this soil, and concave areas of Ladysmith silty clay loam make up 2 percent. Also included are concave areas of soils that are similar to Clark soils, but are 12 to 24 inches deep over lime and are more clayey in the subsoil than in the surface layers. These included soils make up 15 percent of the acreage.

The hazard of water erosion is severe on the Clark soil. Terracing and contour farming help to control erosion. Keeping crop residue at or near the surface helps to maintain soil tilth and organic-matter content and improve moisture penetration. Lime is not needed to establish legumes.

This soil is suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. Capability unit IIIe–5; Limy Upland range site; windbreak group 2.

Clime Series

The Clime series consists of moderately deep, well-drained, gently sloping to sloping soils on uplands. These soils are underlain by calcareous, platy clay shale at a depth of 20 to 40 inches.

In a representative profile the surface layer is dark-gray, weakly calcareous silty clay 9 inches thick. The subsoil is grayish-brown, firm silty clay 9 inches thick. It is calcareous and contains numerous concretions of calcium carbonate and calcium sulfate. The underlying material is light olive-gray, calcareous silty clay 12 inches thick. Below this is light-gray, calcareous clay shale.

Runoff is medium or rapid, and permeability is moderately slow. Fertility is medium, and the available water capacity is low.

Representative profile of Clime silty clay, 1 to 3 percent slopes, in a cultivated field, 125 feet north and 100 feet east of the southwest corner of the SE¼ sec. 7, T. 22 S., R. 2 E.

A1—0 to 9 inches, dark-gray (10YR 4/1) light silty clay, very dark gray (10YR 3/1) moist; moderate, medium, granular structure; hard, firm; weakly calcareous; mildly alkaline; clear, smooth boundary.

B2—9 to 18 inches, grayish-brown (2.5Y 5/2) light silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, subangular blocky structure; very hard, firm; calcareous; numerous concretions of calcium carbonate and calcium sulfate; moderately alkaline; clear, smooth boundary.

C1—18 to 30 inches, light olive-gray (5Y 6/2) light silty clay, olive gray (5Y 5/2) moist; weak, thin, platy structure; hard, firm; calcareous; numerous calcium carbonate concretions; moderately alkaline; gradual, smooth boundary.

C2—30 to 40 inches, light-gray (5Y 7/2), calcareous, platy clay shale that contains seams of brownish yellow (10YR 6/6), olive gray (5Y 5/2) moist; moderately alkaline.

The A horizon ranges from 5 to 10 inches in thickness. Depth to shale ranges from 20 to 40 inches. In most places this soil is calcareous at the surface, but in some places the

upper 10 inches is noncalcareous. The A horizon ranges from very dark gray to very dark grayish brown to gray or grayish brown. It is light silty clay in most places, but it is heavy silty clay loam in some places. It is mildly alkaline or moderately alkaline. The B horizon ranges from dark gray or gray to brown. It is silty clay, clay, or heavy silty clay loam; it is 35 to 45 percent clay. It has moderate or strong, fine or medium, subangular blocky or granular structure. In the mapping unit Clime silty clay, 2 to 6 percent slopes, eroded, the surface layer is lighter colored, thinner, or both than the defined range of the series.

Clime soils are associated with Rosehill soils. They are calcareous at a shallower depth than those soils.

Clime silty clay, 1 to 3 percent slopes (Cd).—This soil is on uplands. It has the profile described as representative of the series. Slopes are convex.

Included areas of Rosehill silty clay make up about 11 percent of the acreage of this soil; areas of Irwin silty clay loam make up 3 percent; and areas of a soil similar to Clime soils, except that depth to shale is 15 to 20 inches, make up 5 percent.

This Clime soil is easily tilled only within a narrow range of moisture conditions. Runoff is medium, and the hazard of erosion is severe. Terraces and contour farming help to control erosion. Good management of crop residue is needed to keep the surface layer porous and to help prevent crusting. Moisture is released slowly.

This soil is suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. The low available water capacity and the possibility of dry weather late in summer make this soil better suited to wheat than to sorghum. Capability unit IIIe–3; Limy Upland range site; windbreak group 8.

Clime silty clay, 3 to 6 percent slopes (Ce).—This soil is on uplands. It has a profile similar to the one described as representative of the series, but the depth to shale is about 27 inches. Slopes are convex.

Included areas of Rosehill silty clay make up about 8 percent of the acreage of this soil, areas of Irwin silty clay loam make up 2 percent, and areas of soil similar to Clime soils, except that depth to shale is 15 to 20 inches, make up 10 percent.

This Clime soil is easily tilled only within a narrow range of moisture conditions. Runoff is rapid, and the hazard of erosion is very severe. Grasses and legumes in the rotation are beneficial. Terraces and contour farming help to control erosion. Keeping crop residue at or near the surface helps maintain soil tilth and the supply of organic matter and improves moisture penetration.

This soil is not well suited to cultivated crops grown year after year. About half the acreage is used for range and half is for wheat and sorghum. The low available water capacity and the possibility of dry weather late in summer make this soil better suited to wheat than to sorghum. Capability unit IVe–1; Limy Upland range site; windbreak group 8.

Clime silty clay, 2 to 6 percent slopes, eroded (Cf).—This soil is on uplands. The profile of this soil differs from the one described as representative of the series in having a thinner, lighter colored surface layer. In most places the surface layer is grayish-brown silty clay. Its thickness is the same as the depth of plowing and ranges from 4 to 8 inches.

Included areas of Rosehill silty clay make up about 5 percent of the acreage of this soil, and areas of a soil similar to eroded Clime soils, except that depth to shale is 10 to 20 inches, make up 15 percent.

Runoff is rapid, and the hazard of erosion is severe. Moisture is released slowly.

All areas of this soil have been cultivated at some time, and most of the acreage is used for crops. A few areas have been reseeded to native grass. Erosion makes this soil better suited to grass than to other uses, and the soil supports good stands of grass if reseeded and properly managed. Capability unit VIe–4; Limy Upland range site; windbreak group 8.

Clime complex, 6 to 12 percent slopes (Cm).—This complex is about 55 percent Clime silty clay; about 35 percent a soil similar to Clime soils, except that it is 25 to 35 percent clay and 10 to 20 inches deep over shale; and about 10 percent Hobbs silt loam and Rosehill silty clay. The Clime silty clay soil has a profile similar to the one described as representative of the series, except that depth to shale is about 27 inches.

Runoff is rapid, and much of the precipitation runs off. The hazard of erosion is severe.

Steep slopes make this complex better suited to grass than to other uses. The acreage is in native grass. Good range management is needed to control erosion and flooding (fig. 6). Capability unit VIe–4; Limy Upland range site; windbreak group 8.

Crete Series

The Crete series consists of deep, moderately well drained, nearly level or gently sloping soils on uplands. These soils formed in loess or old alluvium that has a thin cap of loess.

In a representative profile the surface layer is dark grayish-brown silt loam 11 inches thick. The subsoil is 35 inches thick. The upper 6 inches is dark grayish-brown, firm silty clay loam. The next 17 inches is dark grayish-brown, very firm silty clay that has thin, continuous clay films. The next 6 inches is grayish-brown silty clay that has thin, patchy clay films. The lower 6 inches is light brownish-gray silty clay that has strong-brown mottles and is calcareous. The underlying material is light brownish-gray silty clay loam that has brown mottles.

Runoff is slow or medium, and permeability is slow. Fertility and available water capacity are high.

Representative profile of Crete silt loam, 0 to 1 percent slopes, in a cultivated field, 200 feet west and 50 feet south of the northeast corner of the SE¼ sec. 8, T. 22 S., R. 3 W.

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, very friable; medium acid; clear, smooth boundary.

A1—5 to 11 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate, medium and fine, granular structure; slightly hard, friable; medium acid; clear, smooth boundary.

B1—11 to 17 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine, subangular blocky structure; hard, firm; medium acid; clear smooth boundary.

B21t—17 to 34 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, blocky structure; very hard, very

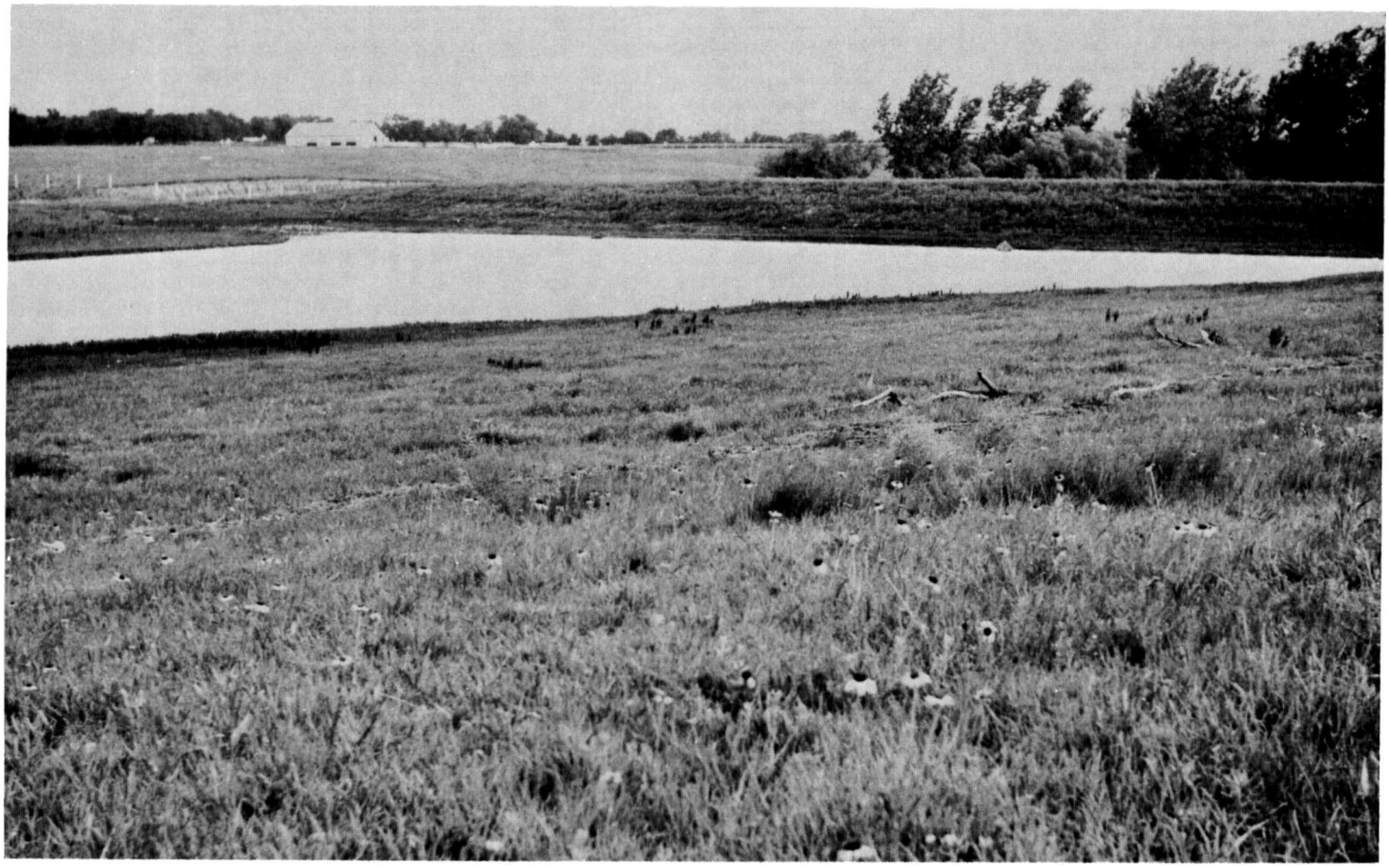

Figure 6.—Detention dam built to stop downstream flooding. Soils are those of Clime complex, 6 to 12 percent slopes.

firm; thin, continuous clay films; neutral; gradual, smooth boundary.

B22t—34 to 40 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate, fine, blocky structure; very hard, very firm; thin, patchy clay films; neutral; clear, smooth boundary.

B3—40 to 46 inches, light brownish-gray (10YR 6/2) light silty clay, dark grayish brown (10YR 4/2) moist; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, blocky structure; hard, firm; calcareous; few calcareous concretions; mildly alkaline; gradual, smooth boundary.

C—46 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam, light brownish gray (10YR 6/2) moist; few, fine, distinct, brown (7.5YR 4/4) mottles; massive; hard, friable; calcareous; mildly alkaline.

The A horizon ranges from 7 to 14 inches in thickness and is light silty clay loam in a few places. It ranges from very dark gray to grayish brown and is medium acid or slightly acid. Depth to the B2t horizon ranges from 14 to 20 inches. The B2t horizon is silty clay that averages 45 to 52 percent clay. It ranges from dark grayish brown, brown, or dark yellowish brown to light brownish gray, pale brown, or light yellowish brown. It is slightly acid or neutral. The depth to calcareous material ranges from about 30 to 50 inches.

The temperature of Crete soils mapped in this county south and west of the Little Arkansas River is warmer than is defined in the range for the series. This difference does not alter the usefulness or behavior of the soils.

Crete soils are associated with Ladysmith, Smolan, and Farnum soils. They have a B1 horizon, which is lacking in Ladysmith soils. They have a less red B2t horizon than Smolan soils. They have a more clayey B2t horizon than Farnum soils.

Crete silt loam, 0 to 1 percent slopes (Cr).—This soil is on uplands. It has the profile described as representative of the series.

Included slightly lower areas of Ladysmith silty clay loam make up about 8 percent of the acreage of this soil, and slightly higher areas of Farnum loam make up 3 percent.

Runoff is slow on this Crete soil. The clayey subsoil is a moderate limitation for crops. Soil blowing is a slight hazard if the surface is bare of vegetation (fig. 7).

This soil is well suited to all crops and grasses commonly grown in the county. Most of the acreage is used for crops. Wheat and sorghum are the main crops, but other small grains and alfalfa are also grown. Some areas have been leveled and are flood irrigated; sorghum, corn, and soybeans are the main crops on these areas. Capability unit IIs–2; Loamy Upland range site; windbreak group 2.

Crete silt loam, 1 to 3 percent slopes (Ct).—This soil is on uplands. It has a profile similar to the one described as representative of the series, but the surface layer averages about 2 inches thinner.

Included areas of Smolan silty clay loam make up about 5 percent of the acreage of this soil, and areas of

Figure 7.—**Emergency tillage to prevent soil blowing. The soil is Crete silt loam, 0 to 1 percent slopes.**

Geary silt loam make up 5 percent. Those included soils are on lower parts of the landscape.

Runoff is medium on this Crete soil, and the hazard of erosion is moderate. Terraces and contour farming help to control erosion. Gradually incorporating crop residue into the soil helps maintain soil tilth and increases moisture penetration.

This soil is well suited to all crops and grasses commonly grown in the county. Most of the acreage is used for crops. Capability unit IIe–2; Loamy Upland range site; windbreak group 2.

Detroit Series

The Detroit series consists of deep, moderately well drained, nearly level soils on flood plains. These soils formed in loamy alluvial sediments.

In a representative profile the surface layer is silty clay loam 11 inches thick. The upper 5 inches is a very dark gray plow layer, and the lower 6 inches is dark gray. The subsoil is 37 inches thick. The upper 6 inches is dark-gray, firm silty clay loam. The next 7 inches is very dark grayish-brown, very firm silty clay. The next 12 inches is grayish-brown, very firm silty clay. The lower 12 inches is light brownish-gray, firm silty clay loam that has faint yellowish-brown mottles and numerous, small, calcareous concretions. The underlying material is pale-brown and grayish-brown silty clay loam mottled with strong brown.

Runoff and permeability are slow. Fertility and available water capacity are high.

Representative profile of Detroit silty clay loam, in a cultivated field, 175 feet north and 75 feet west of the southeast corner of sec. 9, T. 23 S., R. 2 W.

Ap—0 to 5 inches, very dark gray (10YR 3/1) light silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; hard, friable; slightly acid; clear, smooth boundary.

A1—5 to 11 inches, dark-gray (10YR 4/1) light silty clay loam, very dark brown (10YR 2/2) moist; moderate, medium, granular structure; hard, friable; slightly acid; clear, smooth boundary.

B1—11 to 17 inches, dark-gray (10YR 4/1) heavy silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine, subangular blocky structure; hard, firm; slightly acid; clear, smooth boundary.

B21t—17 to 24 inches, very dark grayish-brown (10YR 3/2) light silty clay, very dark brown (10YR 2/2) moist; moderate, fine, blocky structure; very hard, very firm; slightly acid; gradual, smooth boundary.

B22t—24 to 36 inches, grayish-brown (10YR 5/2) light silty clay, very dark grayish brown (10YR 3/2) moist; moderate, medium, blocky structure; very hard, very firm; neutral; gradual, smooth boundary.

B3—36 to 48 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; few, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure;

hard, firm; mass is noncalcareous but contains numerous small calcareous concretions; mildly alkaline; gradual, smooth boundary.

C—48 to 60 inches, pale-brown (10YR 6/3) and grayish-brown (10YR 5/2) silty clay loam, brown (10YR 5/3) and dark grayish brown (10YR 4/2) moist; common, medium, faint, strong-brown (7.5YR 5/6) mottles; massive; hard, firm; mass is calcareous but contains many small and medium calcareous concretions; mildly alkaline.

The A horizon ranges from 8 to 15 inches in thickness and is heavy silt loam or silty clay loam; silty clay loam is dominant. It ranges from very dark gray to grayish brown. The upper part of the solum (the Ap, A1, B1, and B21t horizons) is slightly acid or neutral, and the lower part is neutral or mildly alkaline. The B2t horizon is heavy silty clay loam or light silty clay that averages 35 to 45 percent clay. It ranges from very dark grayish brown to brown. Distinct mottles are below a depth of 50 inches in some places. Depth to lime concretions ranges from about 30 inches to 50 inches.

Detroit soils are associated primarily with Hobbs soils. They have a B2t horizon of clay accumulation that is lacking in Hobbs soils.

Detroit silty clay loam (0 to 1 percent slopes) (De).—This soil is on flood plains. In most places slopes are less than 1 percent, but short slopes of 1 to 4 percent are along shallow drainageways.

Included with this soil in mapping areas along the Little Arkansas River north of Burrton and southeast of Halstead is a soil similar to Detroit soils, but has a more clayey surface layer. This included soil makes up about 5 percent of the acreage. Included areas of salt-affected soils less than 2 acres in size, which are shown on the soil map by a spot symbol, make up about 2 percent; and areas of Hobbs silt loam make up 8 percent.

This Detroit soil is flooded occasionally. The floods vary in intensity and duration from year to year. Some areas benefit from surface drainage in years of more than average rainfall or after floods.

This soil is suited to all crops and grasses commonly grown in the county. Most of the acreage is in wheat and grain sorghum. A small acreage is in alfalfa. Capability unit I–2; Loamy Lowland range site; windbreak group 7.

Dillwyn Series

The Dillwyn series consists of deep, somewhat poorly drained, nearly level soils in low upland areas. These soils formed in sandy eolian material. They have a high water table.

In a representative profile the surface layer is grayish-brown loamy fine sand 8 inches thick. The next layer is brown, very friable loamy fine sand 12 inches thick that has reddish-yellow mottles. The underlying material is loamy fine sand. The upper 28 inches is very pale brown and has reddish-yellow mottles. The rest is light yellowish brown.

Runoff is very slow. Permeability is rapid above the water table, which is at a depth of about 12 inches during wet seasons and drops to a depth of 4 or 5 feet during dry seasons. Fertility and available water capacity are low.

Representative profile of Dillwyn loamy fine sand in an area of Dillwyn-Plevna complex, in native grass, 2,230 feet west and 1,175 feet south of the northeast corner of sec. 7, T. 23 S., R. 3 W.

A1—0 to 8 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; soft, very friable; medium acid; clear, smooth boundary.

AC—8 to 20 inches, brown (10YR 5/3) loamy fine sand, dark grayish brown (10YR 4/2) moist; common, medium, distinct, reddish-yellow (7.5YR 6/6) mottles; weak, medium, granular structure; soft, very friable; medium acid; gradual, smooth boundary.

C1—20 to 48 inches, very pale brown (10YR 7/3) loamy fine sand, brown (10YR 5/3) moist; common, medium, distinct, reddish-yellow (7.5YR 6/6) mottles; single grain; loose; medium acid; gradual, smooth boundary.

C2—48 to 60 inches, light yellowish-brown (10YR 6/4) loamy fine sand, brown (10YR 5/3) moist; single grain; loose; medium acid.

The A horizon ranges from 4 to 10 inches in thickness. It ranges from very dark grayish brown to brown and from medium acid to neutral. The AC horizon ranges from grayish brown to pale brown and from medium acid to neutral. It contains common, fine to coarse, distinct mottles that have higher chromas and redder hues than the matrix. The AC horizon has weak granular structure or is structureless. The C horizon ranges from brown to very pale brown and from medium acid to neutral. It contains common or many, medium or coarse, distinct or prominent mottles that have higher chromas and redder hues than the matrix. The lower part of the C horizon is not mottled in some places.

Dillwyn soils are mapped in complex with Plevna and Tivoli soils in Harvey County. They are more sandy below the A horizon than Plevna soils. They have mottles, which are lacking in Tivoli soils. They are somewhat poorly drained, whereas Tivoli soils are excessively drained.

Dillwyn-Plevna complex (0 to 2 percent slopes) (Dp).—This complex is about 55 percent a Dillwyn loamy fine sand, 30 percent a Plevna fine sandy loam, 10 percent a Tivoli loamy fine sand, and 5 percent a Plevna loamy fine sand. Slopes are nearly level or gently undulating. The dominant slope is less than 2 percent, but in areas where a Tivoli loamy fine sand is included in the complex, slopes are as much as 10 percent.

These soils are used for range. They are too wet for cultivation but are well suited to native grass. During much of the year the water table is high enough to be within the reach of native-grass roots (fig. 8). This feature makes it some of the best acreage in the county for native grass. Capability unit Vw–1; Subirrigated range site; windbreak group 9.

Dillwyn-Tivoli complex (0 to 15 percent slopes) (Dt).—This complex is about 55 percent a Dillwyn loamy fine sand, 35 percent Tivoli fine sand, and 10 percent a Plevna fine sandy loam. The proportion of Dillwyn soil ranges from 30 to 80 percent, and the proportion of Tivoli fine sand ranges from 20 to 70 percent. This complex is nearly level to hummocky. Slopes of the ridges range from 5 to 15 percent. Tivoli fine sand is on the ridges, and nearly level Dillwyn and Plevna soils are on areas between the ridges.

These soils absorb nearly all the precipitation that falls, and no drainage pattern has been established.

These soils are used for range. The hazard of soil blowing on the Tivoli and Dillwyn soils and wetness on the Dillwyn and Plevna soils make them unsuitable for cultivation. Capability unit VIe–1; Dillwyn soil in Subirrigated range site and windbreak group 9; Tivoli soil in Sands range site and windbreak group 6.

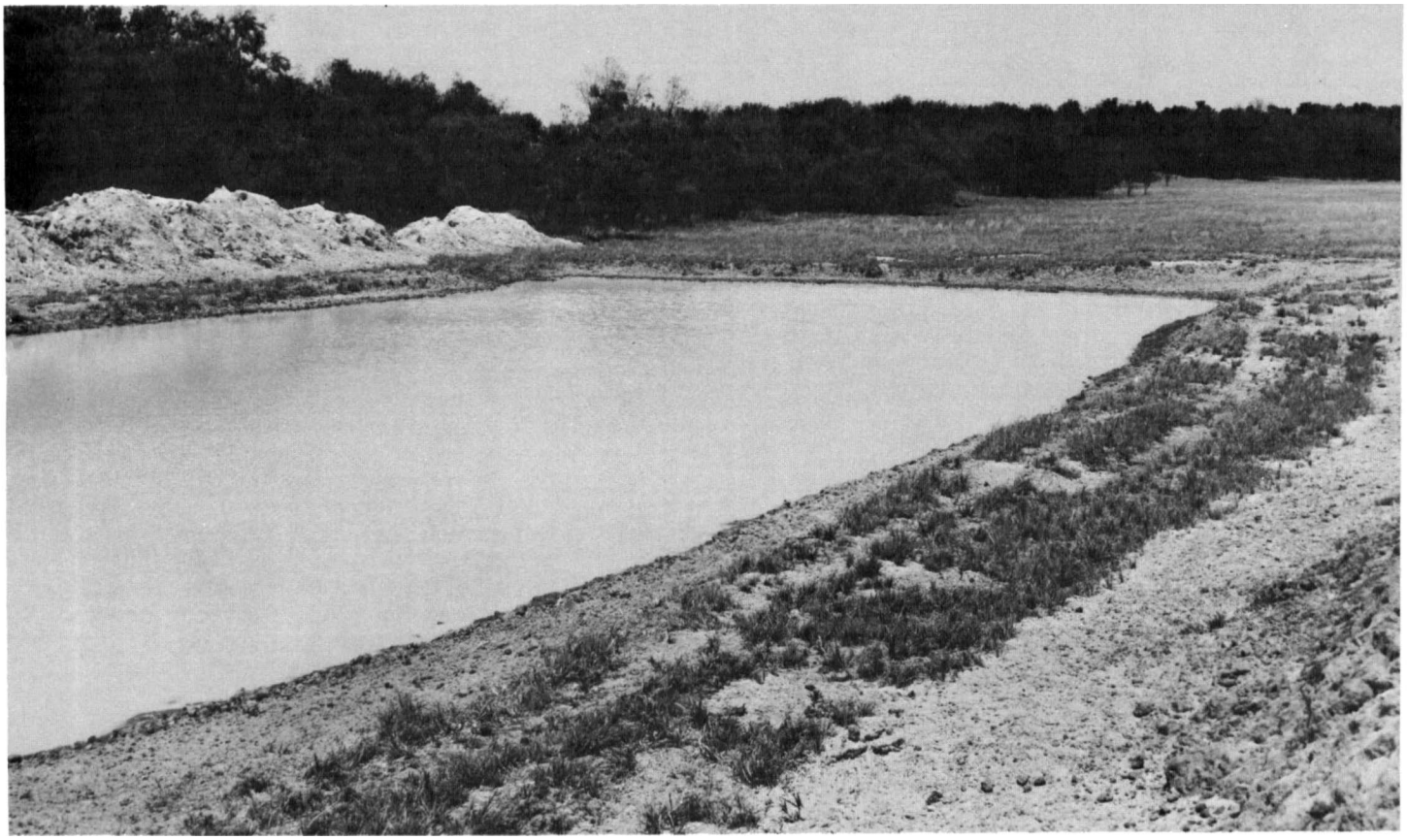

Figure 8.—**Pit pond in an area of Dillwyn-Plevna complex. High water table keeps pond filled.**

Drummond Series

The Drummond series consists of deep, nearly level, somewhat poorly drained soils on uplands. These soils are characterized by salt accumulations in the subsoil and by surface crusting in cultivated areas. They formed in loamy, somewhat stratified old alluvium.

In a representative profile the surface layer is grayish-brown loam 9 inches thick. The subsoil is 21 inches thick. The upper 7 inches is dark-gray, very firm silty clay that contains a few threads of salt crystals. The middle 5 inches is grayish-brown, very firm silty clay that contains many seams and threads of salt crystals. The lower 9 inches is grayish-brown, firm silty clay loam that contains some small lime concretions. The upper 11 inches of the underlying material is light brownish-gray silty clay loam that has yellowish-brown mottles and numerous small and medium lime concretions. The lower part is light-gray silty clay loam that has reddish-yellow mottles and numerous small and medium lime concretions.

Runoff is slow, and permeability is very slow. Fertility is low, and the available water capacity is high. Some areas of Drummond soils have a water table that fluctuates between depths of 5 and 10 feet, but in other areas the water table is below a depth of 10 feet most of the time.

Representative profile of Drummond loam in an area of Drummond complex, in a cultivated field, 400 feet west and 300 feet south of the northeast corner of sec. 14, T. 24 S., R. 3 W.

A1—0 to 9 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; massive when dry, weak, fine, granular structure when moist; hard, very friable; neutral; clear, smooth boundary.

B21t—9 to 16 inches, dark-gray (10YR 4/1) light silty clay, very dark gray (10YR 3/1) moist; moderate, very fine, subangular blocky structure; very hard, very firm; few threads of salt crystals; moderately alkaline; clear, smooth boundary.

B22t—16 to 21 inches, grayish-brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) moist; moderate, fine, subangular blocky structure; very hard, very firm; many seams and threads of salt crystals; moderately alkaline; clear, smooth boundary.

B3—21 to 30 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure; hard, firm; mass is noncalcareous but contains some small lime concretions; moderately alkaline; gradual, smooth boundary.

C1—30 to 41 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; hard, firm; mass is noncalcareous but contains numerous small and medium lime concretions; moderately alkaline; gradual, smooth boundary.

C2—41 to 60 inches, light-gray (5Y 7/2) silty clay loam, olive gray (5Y 5/2) moist; common, medium, distinct, reddish-yellow (7.5YR 6/6) mottles; structureless; hard, firm; mass is noncalcareous but contains nu-

merous small and medium lime concretions; moderately alkaline.

The A horizon ranges from 3 to 12 inches in thickness and is silt loam, very fine sandy loam, loam, clay loam, or silty clay loam. It is dark grayish brown or grayish brown and ranges from slightly acid to mildly alkaline. The B2t horizon is silty clay, clay, heavy silty clay loam, or heavy clay loam; it is 35 to 45 percent clay. It ranges from dark gray to light brownish gray and from neutral to moderately alkaline. The B3 horizon is silty clay loam or clay loam. The C horizon is silty clay loam, clay loam, or sandy clay loam. In most places it is stratified.

Drummond soils are associated with Farnum, Naron, Carwile, and Ladysmith soils. They differ from these soils in having concentrations of soluble salts in the B2t horizon and an A1 horizon that is massive and hard when dry. They have a more clayey B2t horizon than Farnum and Naron soils.

Drummond complex (0 to 1 percent slopes) (Du).—This complex is on uplands. It is 75 percent Drummond soils, 10 percent Farnum loam, 10 percent Ladysmith silty clay loam, and 5 percent Carwile soils. The Farnum, Ladysmith, and Carwile soils do not have the surface crust that is typical of Drummond soils.

Drummond soils contain a large amount of sodium and soluble salts. In cultivated areas, a hard surface crust ½ inch to 2 inches thick forms after rain. These soils are difficult to till because of the surface crust. They dry out slowly after rain. Field crops grow poorly and unevenly.

These soils are better suited to range than to crops. About 75 percent of the acreage is in native grass. Capability unit Vw–2; Saline Lowland range site; windbreak group 9.

Farnum Series

The Farnum series consists of deep, well-drained, nearly level to moderately sloping soils on uplands. These soils formed in loamy, somewhat stratified old alluvium reworked by wind in places.

In a representative profile the surface layer is very dark grayish-brown loam 14 inches thick. The subsoil is 31 inches thick. The upper 6 inches is dark grayish-brown, friable clay loam. The middle 15 inches is dark grayish-brown, firm clay loam. The lower 10 inches is dark grayish-brown, friable sandy clay loam. The underlying material is yellowish-brown sandy loam.

Runoff is slow or medium, and permeability is moderately slow. Fertility and available water capacity are high.

Representative profile of Farnum loam, 0 to 1 percent slopes, in a cultivated field, 500 feet west and 200 feet north of the southeast corner of the SW¼ sec. 16, T. 24 S., R. 3 W.

A1—0 to 14 inches, very dark grayish-brown (10YR 3/2) loam, black (10YR 2/1) moist; moderate, medium, granular structure; slightly hard, friable; medium acid; clear, smooth boundary.

B1—14 to 20 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark brown (10YR 2/2) moist; moderate, medium, granular structure; hard, friable; medium acid; clear, smooth boundary.

B2t—20 to 35 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure; very hard, firm; distinct, continuous clay films; slightly acid; gradual, smooth boundary.

B3—35 to 45 inches, dark grayish-brown (10YR 4/2) sandy clay loam, dark brown (10YR 3/3) moist; weak, medium, blocky structure; hard, friable; slightly acid; gradual, smooth boundary.

C—45 to 60 inches, yellowish-brown (10YR 5/4) sandy loam, brown to dark brown (7.5YR 4/4) moist; massive; slightly hard, friable; neutral.

The A horizon ranges from 7 to 18 inches in thickness and is loam or fine sandy loam. It ranges from very dark grayish brown to grayish brown and from medium acid to neutral. The B2t horizon is clay loam, loam, or sandy clay loam; it is 25 to 35 percent clay. It ranges from dark grayish brown to light yellowish brown and from slightly acid to mildly alkaline. The C horizon is neutral to moderately alkaline. In some places mottles that have chroma of more than 2 occur below a depth of 30 inches.

The temperature in areas of Farnum soils mapped north and east of the Little Arkansas River is cooler than is defined in the range for the series, but this difference does not alter the usefulness or behavior of the soils.

Farnum soils are associated with Carwile, Crete, Geary, Ladysmith, and Naron soils. They have a less clayey B2t horizon than Carwile, Crete, and Ladysmith soils and a more clayey B2t horizon than Naron soils. They have a more sandy B2t horizon than Geary soils.

Farnum fine sandy loam, 0 to 1 percent slopes (Fa).—The profile of this soil differs from the one described as representative of the series in having a surface layer of fine sandy loam 7 to 18 inches thick.

Included lower, concave areas of Carwile fine sandy loam make up about 10 percent of the acreage of this soil; higher, convex areas of Naron fine sandy loam about 5 percent; and areas of Farnum loam about 3 percent.

This Farnum soil is easily tilled throughout a wide range of moisture content. It absorbs most of the precipitation and has slow runoff. Soil blowing is a slight hazard if the surface is bare of vegetation. Blowing can be controlled by stubble mulching and wind stripcropping.

This soil is well suited to irrigation and to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. A small acreage is in alfalfa. Capability unit I–3; Sandy range site; windbreak group 4.

Farnum loam, 0 to 1 percent slopes (Fc).—This soil has the profile described as representative of the series.

Included lower, concave areas of Carwile fine sandy loam make up about 5 percent of the acreage of this soil; higher, convex areas of Naron fine sandy loam about 3 percent; and areas of Farnum fine sandy loam about 2 percent. Also included are areas less than 2 acres in size of salt-affected soils that are shown on the soil map by a spot symbol and make up about 2 percent of the acreage.

Most of the precipitation enters this Farnum soil, and runoff is slow. Keeping crop residue at or near the surface helps maintain soil tilth and the supply of organic matter and improves moisture penetration.

This soil is well suited to irrigation and to all crops and grasses commonly grown in the county. Most of the acreage is in wheat and sorghum. A small acreage is in alfalfa. Capability unit I–1; Loamy Upland range site; windbreak group 2.

Farnum loam, 1 to 3 percent slopes (Fd).—This soil has a profile similar to the one described as representative of the series, but the surface layer is about 2 inches

thinner and in some areas is fine sandy loam.

Included areas of Ladysmith silty clay loam make up about 5 percent of the acreage of this soil; areas of Geary silt loam about 3 percent; and areas of Naron fine sandy loam about 2 percent.

Runoff is medium on this Farnum soil, and the hazard of erosion is moderate. Terraces and contour farming help to control erosion.

This soil is well suited to all the crops and grasses commonly grown in the county. Most of the acreage is in wheat and sorghum. Keeping crop residue at or near the surface helps maintain soil tilth and the supply of organic matter and improves moisture penetration. Capability unit IIe–1; Loamy Upland range site; windbreak group 2.

Farnum loam, 3 to 6 percent slopes (Fe).—This soil has a profile similar to the one described as representative of the series, but the surface layer is about 3 inches thinner.

Included with this soil in mapping are areas of Irwin silty clay loam and Naron fine sandy loam, both of which make up about 3 percent of the acreage.

Runoff is medium on this Farnum soil, and the hazard of erosion is severe. Terraces and contour farming help to control erosion.

This soil is suited to the crops and grasses commonly grown in the county. Slightly more than half the acreage is in wheat and sorghum, and the rest is in native grass. Keeping crop residue at or near the surface helps maintain soil tilth and the supply of organic matter and improves moisture penetration. Grasses and legumes in the rotation are beneficial. Capability unit IIIe–2; Loamy Upland range site; windbreak group 2.

Farnum-Slickspots complex (0 to 1 percent slopes) (Fs).—This complex is about 60 percent Farnum loam, 25 percent Slickspots, and 15 percent soils intermediate between the two. The proportion of Farnum loam ranges from 40 to 80 percent, and that of Slickspots from 5 to 45 percent. Some local areas contain small amounts of Ladysmith silty clay loam, Naron fine sandy loam, and Carwile fine sandy loam. In most places slopes are less than 1 percent, but some short slopes along small drainageways are as much as 4 percent.

Slickspots have a light-colored surface layer, ½ inch to 2 inches thick, that forms a crust when dry, but puddles after heavy rain. The texture is silt loam, loam, clay loam, or silty clay loam. The subsoil is clay loam, silty clay loam, or silty clay that is massive or has weak, blocky structure. In most places the subsoil contains some white crystalline salts. The amount and distribution of salts and alkali vary. The intermediate soils in this complex are similar to the Farnum soil but are affected to varying degrees by salt and alkali.

About 75 percent of the acreage is cultivated. Wheat and sorghum are the main crops, and a small acreage is in alfalfa. Crop growth is poor in salt-affected areas, and it is difficult to obtain an even stand. A surface crust forms after rains, and the soils do not dry out readily. The organic-matter content is low, tilth is poor, and tillage is difficult. Water sometimes ponds. Adding manure and keeping crop residue on or near the surface improve these salt-affected areas. Capability unit IVs–1; Farnum soil in Loamy Upland range site and windbreak group 2; Slickspots in Saline Lowland range site and windbreak group 9.

Geary Series

The Geary series consists of deep, well-drained, nearly level to moderately sloping soils on uplands. These soils formed in loess or loamy alluvium.

In a representative profile the surface layer is dark grayish-brown silt loam 9 inches thick. The subsoil is 26 inches thick. The upper 6 inches is very dark grayish-brown, firm silty clay loam; the middle 11 inches is reddish-brown, firm silty clay loam; and the lower 9 inches is reddish-brown, firm clay loam. The underlying material is reddish-brown clay loam.

Runoff is slow or medium, and permeability is moderate. Fertility and available water capacity are high.

Representative profile of Geary silt loam, 1 to 3 percent slopes, in a cultivated field, 1,925 feet south and 155 feet east of the northwest corner of sec. 21, T. 23 S., R. 1 W.

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, friable; medium acid; clear, smooth boundary.

B1—9 to 15 inches, very dark grayish-brown (10YR 3/2) light silty clay loam, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky structure; hard, firm; medium acid; clear, smooth boundary.

B2t—15 to 26 inches, reddish-brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; moderate, fine, subangular blocky structure; hard, firm; medium acid; gradual, smooth boundary.

B3—26 to 35 inches, reddish-brown (5YR 5/4) light clay loam, reddish brown (5YR 4/4) moist; weak, coarse, subangular blocky structure; hard, firm; slightly acid; gradual, smooth boundary.

C—35 to 60 inches, reddish-brown (5YR 5/4) light clay loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable; slightly acid.

The A horizon ranges from 6 to 13 inches in thickness and is silt loam or loam. It ranges from very dark grayish brown to brown and is medium acid or slightly acid. The B2t horizon is brown, strong brown, light brown, reddish yellow, yellowish red, reddish brown, or light reddish brown and ranges from medium acid to neutral. It ranges from about 27 to 35 percent clay. It has subangular blocky or blocky structure. The C horizon has colors similar to the B2t horizon. It is slightly acid or neutral and is light clay loam or light silty clay loam.

The temperature of Geary soils mapped in this county south and west of the Little Arkansas River is warmer than is defined in the range for the series. This difference, however, does not affect the usefulness or behavior of the soils.

Geary soils are associated with Crete and Smolan soils and, less extensively, with Farnum and Naron soils. They have a less clayey B2t horizon than Crete and Smolan soils and a less sandy B2t horizon than Farnum and Naron soils.

Geary silt loam, 0 to 1 percent slopes (Gc).—Included lower areas of Crete silt loam make up about 10 percent of the acreage of this soil, and lower areas of Ladysmith silty clay loam 2 percent.

This Geary soil absorbs most of the precipitation, and runoff is slow. Keeping crop residue at or near the surface helps maintain soil tilth and the supply of organic matter and improves moisture penetration.

This soil is well suited to irrigation and to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. Capability unit I–1; Loamy Upland range site; windbreak group 2.

Geary silt loam, 1 to 3 percent slopes (Gd).—This soil has the profile described as representative of the series.

Included higher areas of Crete silt loam make up about 10 percent of the acreage of this soil, and higher areas of Smolan silty clay loam 5 percent.

Runoff is medium on this Geary soil, and the hazard of erosion is moderate. Terraces and contour farming help to control erosion. Keeping crop residue at or near the surface helps maintain soil tilth and the supply of organic matter and improves moisture penetration.

This soil is well suited to all the crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. A small acreage is in alfalfa. Capability unit IIe–1; Loamy Upland range site; windbreak group 2.

Geary silt loam, 3 to 6 percent slopes (Ge).—The profile of this soil differs from the one described as representative of the series in having a thinner surface layer.

Included areas of soils similar to Geary soils, except that the subsoil averages 35 to 40 percent clay, make up about 20 percent of the acreage.

Runoff is medium on this Geary soil, and the hazard of erosion is severe. Terraces and contour farming help to control erosion. Keeping crop residue at or near the surface helps maintain soil tilth and the supply of organic matter and improves moisture penetration. Grasses and legumes in the rotation are beneficial.

This soil is suited to all crops and grasses commonly grown in the county. About 75 percent of the acreage is used for wheat and sorghum, and the rest is used for range. Capability unit IIIe–2; Loamy Upland range site; windbreak group 2.

Goessel Series

The Goessel series consists of deep, moderately well drained, nearly level to gently sloping soils on uplands. These soils formed in clayey old alluvium.

In a representative profile the surface layer is 15 inches thick. The upper 6 inches is a dark-gray silty clay plow layer. The lower 9 inches is very dark gray silty clay. The next 15 inches is gray, very firm silty clay. Below this is 20 inches of gray, very firm silty clay that has brown mottles. The underlying material is light brownish-gray silty clay that has brown mottles.

Runoff is slow to medium, and permeability is very slow. Fertility is medium, and the available water capacity is high.

Representative profile of Goessel silty clay, 0 to 1 percent slopes, in a cultivated field, 185 feet north and 25 feet west of the southeast corner of the SW¼ sec. 30, T. 22 S., R. 1 E.

Ap—0 to 6 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate, fine, granular structure; very hard, firm; slightly acid; clear, smooth boundary.

A1—6 to 15 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; moderate, fine, blocky structure; very hard, very firm; slightly acid; gradual, smooth boundary.

AC1—15 to 24 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; moderate, fine, blocky structure; extremely hard, very firm; mildly alkaline; gradual, smooth boundary.

AC2—24 to 30 inches, gray (5Y 5/1) silty clay, dark gray (5Y 4/1) moist; moderate, fine, blocky structure; extremely hard, very firm; mildly alkaline; gradual, smooth boundary.

AC3—30 to 50 inches, gray (2.5Y 5/1) silty clay, dark gray (2.5Y 4/1) moist; common, fine, distinct, brown (7.5YR 5/4) mottles; weak, fine, blocky structure; extremely hard, very firm; mildly alkaline; gradual, smooth boundary.

C—50 to 60 inches, light brownish-gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; common, medium, distinct, brown (7.5YR 5/4) mottles; massive; very hard, very firm; mildly alkaline.

The A horizon ranges from 9 to 20 inches in thickness and is very dark gray or dark gray. In most places it is silty clay, but heavy silt clay loam or clay is in the range. It is slightly acid or neutral. The AC horizon ranges from very dark gray to grayish brown and is mildly alkaline or moderately alkaline. In most places it is silty clay, but clay is in the range. It is 40 to 60 percent clay. The C horizon ranges from very dark gray to light yellowish brown. In most places it is silty clay, but it is clay or heavy clay loam in some places. Calcareous concretions are at a depth of more than 30 inches in many places.

Goessel soils are associated primarily with Ladysmith and Rosehill soils and less extensively with Irwin and Clime soils. They have a more clayey A horizon than Ladysmith and Irwin soils and are deeper over shale than Rosehill and Clime soils.

Goessel silty clay, 0 to 1 percent slopes (Go).—This soil has the profile described as representative of the series.

Included areas of Ladysmith silty clay loam make up about 15 percent of the acreage of this soil.

Runoff is slow on this Goessel soil. The clayey texture is a moderate limitation for growing crops. Improvement of drainage is needed in places (fig. 9). Good management of crop residue is needed to keep the surface layer porous and help prevent crusting. Tillage is difficult and is limited to a narrow range of moisture conditions. Moisture is released slowly.

Most of the acreage is used for wheat and sorghum. Capability unit IIs–1; Clay Upland range site; windbreak group 1.

Goessel silty clay, 1 to 2 percent slopes (Gs).—Included areas of Ladysmith silty clay loam make up about 10 percent of the acreage of this soil, and Rosehill silty clay 5 percent.

Runoff is medium on this Goessel soil, and the hazard of erosion is severe. Terraces and contour farming help to control erosion. Good management of crop residue is needed to keep the surface layer porous and help prevent crusting. Moisture is released slowly. Tillage is difficult and is limited to a narrow range of moisture conditions.

This soil is suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. Capability unit IIIe–1; Clay Upland range site; windbreak group 1.

Hobbs Series

The Hobbs series consists of deep, nearly level, well-drained soils on flood plains. These soils are flooded occasionally to frequently. They formed in loamy alluvium.

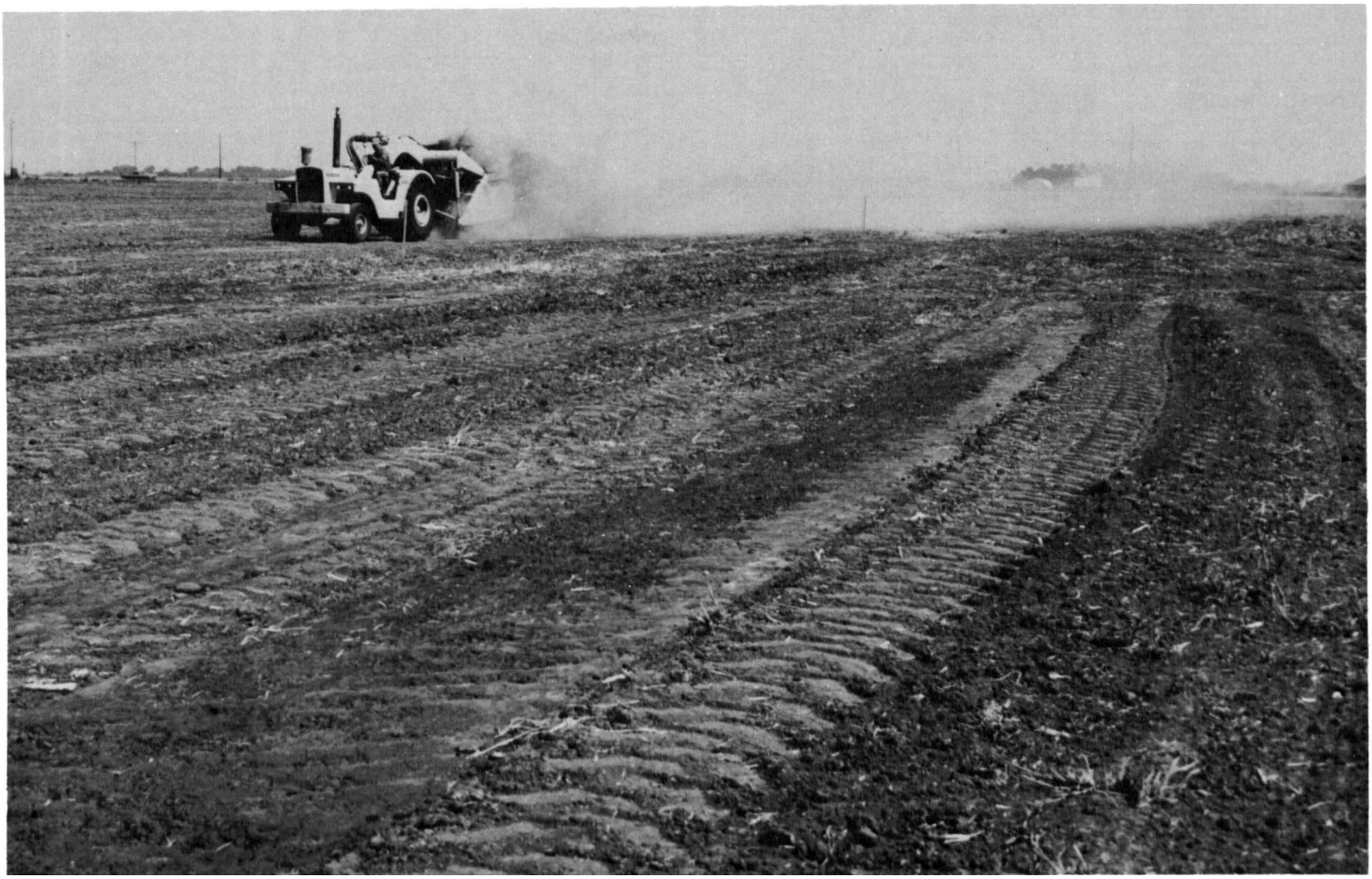

Figure 9.—**Land smoothing to improve drainage. The soil is Goessel silty clay, 0 to 1 percent slopes.**

In a representative profile the surface layer is dark-gray silt loam 26 inches thick. The next layer is dark grayish-brown, friable silt loam 16 inches thick. The underlying material is grayish-brown silt loam.

Runoff is slow, and permeability is moderate. Fertility and available water capacity are high.

Representative profile of Hobbs silt loam, in a cultivated field, 150 feet west and 100 feet south of the northeast corner of the NW¼ sec. 3, T. 22 S., R. 3 W.

A1—0 to 26 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) moist; weak, medium, granular structure; slightly hard, friable; slightly acid; gradual, smooth boundary.

AC—26 to 42 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; slightly hard, friable; slightly acid; diffuse, smooth boundary.

C—42 to 60 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable; neutral.

The A horizon ranges from 15 to 30 inches in thickness and from dark gray to grayish brown. It is silt loam or silty clay loam in most places, but in a few places it is fine sandy loam. It is slightly acid or neutral. The AC horizon ranges from dark gray to light brownish gray and is slightly acid or neutral. It is silt loam or silty clay loam and averages about 23 to 33 percent clay. Stratification in this horizon is distinct in some places and very faint in others. The AC horizon has granular or weak subangular blocky structure. The C horizon ranges from gray to very pale brown and is neutral or mildly alkaline. It is silt loam or silty clay loam in most places, but in some places unconforming, more sandy or more clayey strata occur below a depth of 40 inches. Distinct mottles and calcareous material do not occur within a depth of 40 inches.

Hobbs soils are associated mainly with Detroit soils. They do not have the B2t horizon of clay accumulation that Detroit soils have. The AC horizon of Hobbs soils is less sandy than the B2 horizon of Kaski soils, which occur nearby.

Hobbs silt loam (0 to 1 percent slopes) (Ho).—This soil is on flood plains. The dominant slope is less than 1 percent, but short slopes are as much as 4 percent.

Included areas of Detroit silty clay loam make up about 10 percent of the acreage of this soil.

This Hobbs soil is subject to flooding at occasional to frequent intervals. Not much damage is done to crops in most floods, and the water recedes in a few days. The water table is generally below a depth of 5 feet except during floods.

This soil is well suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. Areas that have a surface layer of fine sandy loam have a slight hazard of soil blowing if bare of vegetation. Keeping crop residue at or near the surface helps maintain soil tilth and the supply of organic matter and improves moisture penetration. Capability

unit IIw–1; Loamy Lowland range site; windbreak group 7.

Irwin Series

The Irwin series consists of deep, well-drained, gently sloping or moderately sloping soils on uplands. These soils formed in clayey sediments believed to be old alluvium.

In a representative profile the surface layer is dark-gray silty clay loam 11 inches thick. The subsoil is silty clay 33 inches thick. The upper 25 inches is dark grayish brown and very firm; the lower 8 inches is firm and brown mottled with yellowish brown. The underlying material is light yellowish-brown and grayish-brown silty clay.

Runoff is medium or rapid, and permeability is very slow. Fertility is medium, and the available water capacity is high.

Representative profile of Irwin silty clay loam, 1 to 3 percent slopes, in a cultivated field, 375 feet east and 125 feet north of the southwest corner of sec. 27, T. 22 S., R. 2 E.

Ap—0 to 6 inches, dark-gray (10YR 4/1) light silty clay loam, black (10YR 2/1) moist; weak, medium, granular structure; slightly hard, friable; medium acid; clear, smooth boundary.

A1—6 to 11 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate, medium, granular structure; hard, friable; medium acid; clear, smooth boundary.

B2t—11 to 36 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, medium, blocky structure; very hard, very firm; slightly acid; gradual, smooth boundary.

B3—36 to 44 inches, brown (10YR 5/3) silty clay, dark grayish brown (10YR 4/2) moist; few, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, medium, blocky structure; hard, firm; mass noncalcareous but contains few, medium, calcareous concretions; neutral; gradual, smooth boundary.

C—44 to 60 inches, light yellowish-brown (2.5Y 6/4) and grayish-brown (2.5Y 5/2) silty clay, olive brown (2.5Y 4/4) and very dark grayish brown (2.5Y 3/2) moist; massive; hard, firm; neutral.

The A horizon ranges from 6 to 14 inches in thickness and from dark gray to grayish brown. In most places it is silty clay loam, but in some places it is heavy silt loam or clay loam. It is medium acid or slightly acid. The B2t horizon ranges from dark grayish brown to brown and from medium acid to neutral. It is silty clay or clay that averages 40 to 60 percent clay. The C horizon ranges from dark grayish brown to yellow and is neutral or mildly alkaline. In some places shale occurs below a depth of 40 inches. Distinct mottles that have chromas of less than 2 do not occur above a depth of 40 inches. In the mapping unit Irwin silty clay loam, 2 to 6 percent slopes, eroded, the surface layer is thinner than the defined range of the series.

Irwin soils are associated with Rosehill, Clime, Ladysmith, Goessel, and Farnum soils. They are deeper over shale and have a less clayey A1 horizon than Rosehill and Clime soils. They have a browner B21t horizon than Ladysmith soils, a less clayey A1 horizon than Goessel soils, and a more clayey B2t horizon than Farnum soils.

Irwin silty clay loam, 1 to 3 percent slopes (Ir).—This soil has the profile described as representative of the series.

Included areas of Rosehill silty clay make up about 5 percent of the acreage of this soil, areas of Clime silty clay and lower areas of Farnum loam each make up 3 percent, higher areas of Ladysmith silty clay loam make up about 10 percent, and scattered, slightly concave areas of Goessel silty clay make up 2 percent.

Runoff is medium on this Irwin soil, and the hazard of erosion is severe (fig. 10). Terraces, contour farming, and waterways help to control erosion. Good management of crop residue is needed to keep the surface layer porous and help prevent crusting. Tillage is limited to a narrow range of moisture conditions. Moisture is released slowly.

This soil is suited to all crops and grasses commonly grown in the county. About 75 percent of the acreage is used for wheat and sorghum. A small acreage is in alfalfa. Capability unit IIIe–1; Clay Upland range site; windbreak group 1.

Irwin silty clay loam, 3 to 6 percent slopes (Is).—Included areas of Rosehill silty clay make up about 5 percent of the acreage of this soil, and lower areas of Clime silty clay make up 5 percent.

Runoff is rapid on this Irwin soil, and much of the precipitation runs off. The hazard of erosion is severe. Terraces and contour farming help to control erosion, and grasses and legumes in the rotation are beneficial. Keeping crop residue at or near the surface helps improve soil tilth and the supply of organic matter and improves moisture penetration. Tillage is limited to a narrow range of moisture conditions. Moisture is released slowly.

This soil is not well suited to cultivated crops grown year after year. About half the acreage is used for range, and half is in wheat and sorghum. Capability unit IIIe–6; Clay Upland range site; windbreak group 1.

Irwin silty clay loam, 2 to 6 percent slopes, eroded (It).—This soil has a surface layer that is 3 to 9 inches thick. It is silty clay loam or heavy silty clay loam. In about 60 percent of the area, the surface layer has been mixed with material from the subsoil and is lighter colored and more clayey. Shallow gullies and rills are common.

Included areas of Rosehill silty clay make up about 3 percent of the acreage of this soil, and lower lying areas of Clime silty clay make up 2 percent. Runoff is rapid on this Irwin soil, and much of the precipitation runs off. The hazard of erosion is very severe. Terraces and contour farming help to control erosion, and grasses and legumes in the rotation are beneficial. Keeping crop residue at or near the surface helps improve soil tilth, the supply of organic matter, and moisture penetration. Tillage is limited to a narrow range of moisture conditions. Moisture is released slowly.

Because this soil is already moderately eroded and is subject to further erosion, it is not well suited to cultivated crops grown year after year. It is used for wheat and sorghum. Capability unit IVe–2; Clay Upland range site; windbreak group 1.

Kaski Series

The Kaski series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy alluvium that is stratified in many places.

In a representative profile the surface layer is loam 24 inches thick. The upper 7 inches is a dark-gray plow

Figure 10.—**Erosion on Irwin silty clay loam, 1 to 3 percent slopes. Sediments collect in fields and road ditches.**

layer; the lower 17 inches is very dark gray. The subsoil is 17 inches thick. The upper 8 inches is very dark gray, firm clay loam; the lower 9 inches is dark-gray and grayish-brown, firm clay loam mottled with brown to dark brown. The underlying material is grayish-brown clay loam mottled with brown.

Runoff is slow, and permeability is moderate. Fertility and available water capacity are high.

Representative profile of Kaski loam, in a cultivated field, 240 feet south and 150 feet east of the northwest corner of SW¼ sec. 15, T. 24 S., R. 1 E.

Ap—0 to 7 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak, medium, granular structure; slightly hard, friable; medium acid; clear, smooth boundary.

A1—7 to 24 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak, medium, granular structure; hard, friable; medium acid; clear, smooth boundary.

B21—24 to 32 inches, very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure; hard, firm; medium acid; clear, smooth boundary.

B22—32 to 41 inches, dark-gray (10YR 4/1) and grayish-brown (10YR 5/2) clay loam, very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) moist; common, fine, distinct, brown to dark-brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure; hard, firm; medium acid; gradual, smooth boundary.

C—41 to 60 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; few, fine, distinct, brown (7.5YR 5/4) mottles; massive; slightly hard, firm; few, small, black concretions; medium acid.

The A horizon ranges from 15 to 35 inches in thickness. It is loam in most places but ranges from fine sandy loam to clay loam. It ranges from very dark gray to grayish brown and is medium acid or slightly acid. The B horizon is loam or clay loam and averages 20 to 35 percent clay. It ranges from very dark gray to light yellowish brown and from medium acid to neutral. Stratification of color and texture is evident in most places. The B horizon has weak subangular blocky or granular structure. The C horizon ranges from grayish brown to light yellowish brown and from medium acid to neutral. Distinct mottles do not occur above a depth of 30 inches. Strata of loamy fine sandy or coarser materials occur below a depth of 40 inches in a few places.

The temperature of Kaski soils mapped in this county north and east of the Little Arkansas River is cooler than is defined in the range for the series. This difference does not alter the usefulness or behavior of the soils.

Kaski soils are associated with Hobbs soils. They are more sandy below the A horizon than Hobbs soils.

Kaski loam (0 to 1 percent slopes) (Ka).—This soil is on flood plains.

Included areas of Hobbs silt loam make up about 10 percent of the acreage of this soil.

This Kaski soil is subject to flooding at occasional to frequent intervals. Not much damage is done in most floods, and the water recedes in a few days. The water table is generally below a depth of 5 feet except during floods. Areas that have a surface layer of fine sandy loam have a slight hazard of soil blowing if bare of vegetation. Keeping crop residue at or near the surface helps improve soil tilth and the supply of organic matter and improves moisture penetration.

This soil is well suited to all crops and grasses commonly grown in the county. About 75 percent of the acreage is used for crops. Capability unit IIw–1; Loamy Lowland range site; windbreak group 7.

Ladysmith Series

The Ladysmith series consists of deep, moderately well drained, nearly level or gently sloping soils on uplands. These soils formed mainly in clayey old alluvium.

In a representative profile the surface layer is dark-gray silty clay loam 10 inches thick. The subsoil is very firm silty clay 35 inches thick. The upper 13 inches is dark gray, the middle 10 inches is grayish brown, and the lower 12 inches is grayish brown mottled with yellowish brown. The underlying material is grayish-brown silty clay loam mottled with reddish brown.

Runoff is slow or medium, and permeability is very slow. Fertility is medium, and the available water capacity is high.

Representative profile of Ladysmith silty clay loam, 0 to 1 percent slopes, in a cultivated field, 850 feet east and 125 feet north of the southwest corner of sec. 18, T. 24 S., R. 1 E.

Ap—0 to 5 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, coarse, granular structure parting to weak, fine, granular; slightly hard, friable; medium acid; abrupt, smooth boundary.

A1—5 to 10 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; medium acid; clear, smooth boundary.

B21t—10 to 23 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 31) moist; moderate, medium, blocky structure parting to moderate, fine, blocky; very hard, very firm; thin, continuous clay films; slightly acid; gradual, smooth boundary.

B22t—23 to 33 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak, medium, blocky structure; very hard, very firm; thin, continuous clay films; slightly acid; gradual, smooth boundary.

B3—33 to 45 inches, grayish-brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) moist; common, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, medium, blocky structure; very hard, very firm; neutral; gradual, smooth boundary.

C—45 to 60 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; common, medium, distinct, reddish-brown (5YR 5/3) mottles; massive; hard, firm; neutral.

The A horizon ranges from 6 to 14 inches in thickness. It ranges from very dark gray to grayish brown and is medium acid or slightly acid. It is dominantly silty clay loam, but most Ladysmith soils in the Carwile-Ladysmith association have an A horizon of clay loam or loam. The B2t horizon is silty clay or clay that averages 40 to 60 percent clay. It ranges from very dark gray to grayish brown and from medium acid to neutral. The C horizon is silty clay, clay, or silty clay loam. It ranges from gray to very pale brown or pale yellow and is neutral or mildly alkaline. Distinct mottles do not occur above a depth of 30 inches. In some places calcareous concretions occur below a depth of 30 inches.

The temperature of Ladysmith soils mapped in this county south and west of the Little Arkansas River is warmer than is defined in the range for the series. This does not alter the usefulness and behavior of the soils.

Ladysmith soils are associated with Crete, Goessel, Irwin, Farnum, and Carwile soils. They have a grayer B21t horizon than Irwin soils, a less clayey A1 horizon than Goessel soils, and a more clayey B2t horizon than Farnum soils. They do not have the B1 horizon of Crete soils. They do not have the mottles in the B21t horizon that are typical of Carwile soils.

Ladysmith silty clay loam, 0 to 1 percent slopes (La).—This soil has the profile described as representative of the series. Some areas that have a surface layer of clay loam or loam are in the southwestern part of the county.

Included areas of Irwin silty clay loam make up about 5 percent of the acreage of this soil, areas of Goessel silty clay and Farnum loam each make up 3 percent, and areas of Crete silt loam and Carwile fine sandy loam each make up 2 percent.

Runoff is slow on this Ladysmith soil. The clayey subsoil is a moderate limitation for crops. The hazard of erosion is slight on long slopes of more than 0.5 percent. Surface drainage is needed in places, and good management of crop residue is needed to keep the surface layer porous and help prevent crusting. Tillage is limited to a narrow range of moisture conditions. Moisture is released slowly.

This soil is well suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. It is suitable for leveling for irrigation where drainage and water quality are adequate. Capability unit IIs–1; Clay Upland range site; windbreak group 1.

Ladysmith silty clay loam, 1 to 2 percent slopes (Lb).—This soil primarily has slopes of 1 to 2 percent, but in some areas slopes are 3 percent. About 10 percent of the acreage has slopes of ½ to 1 percent.

Included areas of Irwin silty clay loam make up about 15 percent of the acreage of this soil; areas of Farnum loam 3 percent; and areas of Goessel silty clay 2 percent.

Runoff is medium on this Ladysmith soil, and the hazard of erosion is severe. Terraces and contour farming help to control erosion. Good management of crop residue is needed to keep the surface layer porous and help prevent crusting. Tillage is limited to a narrow range of moisture conditions. Moisture is released slowly.

This soil is suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. Capability unit IIIe–1; Clay Upland range site; windbreak group 1.

Ladysmith-Slickspots complex (0 to 1 percent slopes) (Ld).—This complex is on low terraces that are occasionally flooded. It is 40 to 80 percent Ladysmith silty clay loam, 5 to 45 percent Slickspots, and 15 to 25 percent soils in-

termediate between the two. The proportion of Ladysmith silty clay loam is about 60 percent, and Slickspots and intermediate soils are each 20 percent. Slopes are mostly less than 1 percent, but there are short slopes of 1 to 4 percent along shallow drainageways.

Slickspots have a light-colored surface layer, ½ inch to 2 inches thick, that forms a crust when dry, but puddles after heavy rain. The texture is silt loam, loam, clay loam, or silty clay loam. The subsoil is clay loam, silty clay loam, or silty clay that is massive or has weak blocky structure. In most places the subsoil contains some white crystalline salts. The amount and distribution of salts and alkali vary. The intermediate soils in this complex are similar to the Ladysmith soil but are affected to varying degrees by salt and alkali.

About two-thirds of the acreage is used for wheat and sorghum; the rest is used for range. Crop growth is uneven due to the variability of the soils. Crop growth is poor in the salt-affected areas, which are difficult to till and do not dry out readily. Adding manure and keeping crop residue on or near the surface improve these salt-affected areas. Capability unit IVs–1; Ladysmith soil in Clay Lowland range site and windbreak group 1; Slickspots in Saline Lowland range site and windbreak group 9.

Lesho Series

The Lesho series consists of moderately deep, nearly level, somewhat poorly drained soils on low terraces. These soils formed in stratified, calcareous alluvium and consist of loamy sediments over distinctly contrasting sandy sediments.

In a representative profile the surface layer is dark grayish-brown, calcareous loam 17 inches thick. The next layer is grayish-brown, calcareous clay loam 13 inches thick mottled with brown. The underlying sandy material is 30 inches thick. The upper 12 inches is pale-brown, calcareous loamy sand. The middle 12 inches is pale-brown and yellowish-brown loamy sand. The lower part is very pale brown fine sand.

Runoff is slow, and permeability is moderately slow. Fertility is medium, and the available water capacity is moderate. The water table fluctuates between depths of about 2 and 5 feet.

Representative profile of Lesho loam, in a cultivated field, 1,575 feet west and 200 feet north of the southeast corner of sec. 31, T. 24 S., R. 3 W.

A11—0 to 9 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak, medium, granular structure; slightly hard, friable; weakly calcareous; mildly alkaline; clear, smooth boundary.

A12—9 to 17 inches, dark grayish-brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

C—17 to 30 inches, grayish-brown (10YR 5/2) light clay loam, dark grayish brown (10YR 4/2) moist; common, fine, distinct, brown (7.5YR 5/4) mottles; weak, medium, granular structure; hard, friable; calcareous; moderately alkaline; gradual, smooth boundary.

IIC1—30 to 42 inches, pale-brown (10YR 6/3) loamy sand, brown to dark brown (10YR 4/3) moist; single grain; loose; calcareous; moderately alkaline; gradual, smooth boundary.

IIC2—42 to 54 inches, pale-brown (10YR 6/3) and yellowish-brown (10YR 5/6) loamy sand, brown (10YR 5/3) and dark yellowish brown (10YR 4/4) moist; single grain; loose; mildly alkaline; gradual, smooth boundary.

IIC3—54 to 60 inches, very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) moist; single grain; loose; mildly alkaline.

The A horizon ranges from 10 to 20 inches in thickness. It ranges from very dark grayish brown to grayish brown and is loam or clay loam. During most years this soil is continuously saturated with water at a depth of less than 40 inches for more than 90 days. Depth to calcareous material ranges from 0 to 12 inches, and the horizon is mildly alkaline or moderately alkaline. Depth to distinct mottles ranges from 14 to 30 inches. The C horizon is clay loam, loam, or sandy clay loam that is 20 to 35 percent clay. It ranges from dark yellowish brown to light brownish gray. Depth to the IIC horizon ranges from 18 to 40 inches. The IIC horizon ranges from loamy fine sand to coarse sand.

Lesho soils are associated with Kaski soils. They differ from those soils in having contrasting sandy strata within a depth of 40 inches, being calcareous within a depth of 12 inches, and having a water table within a depth of 5 feet.

Lesho loam (0 to 1 percent slopes) (le).—Included areas of Carwile fine sandy loam make up about 2 percent of the acreage of this soil, and areas of soils similar to Lesho soils, except that they do not have contrasting sandy strata within a depth of 40 inches, make up 10 percent.

This Lesho soil is seldom flooded. The water table fluctuates between depths of about 2 and 5 feet. Keeping crop residue at or near the surface helps improve soil tilth, the supply of organic matter, and moisture penetration.

This soil is suited to most crops and grasses commonly grown in the county. About half the acreage is used for wheat and sorghum. A small acreage is in alfalfa, but alfalfa is not well suited because the water table is high.

About half the acreage is used for range. It produces an abundance of good-quality forage, because the water table is within the reach of native-grass roots much of the year. This soil is suitable for leveling and irrigation where drainage is adequate. Capability unit IIIw–1; Subirrigated range site; windbreak group 7.

Naron Series

The Naron series consists of deep, well-drained, nearly level or gently sloping soils on uplands. These soils formed in loamy eolian material or outwash.

In a representative profile the surface layer is grayish-brown fine sandy loam 10 inches thick. The subsoil is 30 inches thick. The upper 6 inches is brown to dark-brown, friable fine sandy loam. The middle 15 inches is brown to dark-brown, friable sandy clay loam. The lower 9 inches is brown, friable fine sandy loam. The underlying material is brown fine sandy loam.

Runoff is slow, and permeability is moderate. Fertility is medium, and the available water capacity is moderate.

Representative profile of Naron fine sandy loam, 1 to 4 percent slopes, in a cultivated field, 750 feet south and 150 feet east of the northwest corner of sec. 30, T. 24 S., R. 2 W.

A1—0 to 10 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist;

weak, medium, granular structure; slightly hard, very friable; medium acid; clear, smooth boundary.

B1—10 to 16 inches, brown to dark-brown (10YR 4/3) heavy fine sandy loam, dark brown (10YR 3/3) moist; weak, coarse, subangular blocky structure; slightly hard, friable; medium acid; clear, smooth boundary.

B2t—16 to 31 inches, brown to dark-brown (10YR 4/3) light sandy clay loam, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure; hard, friable; slightly acid; gradual, smooth boundary.

B3—31 to 40 inches, brown (10YR 5/3) heavy fine sandy loam, brown to dark brown (10YR 4/3) moist; weak, coarse, subangular blocky structure; slightly hard, friable; slightly acid; gradual, smooth boundary.

C—40 to 60 inches, brown (10YR 5/3) fine sandy loam, brown to dark brown (10YR 4/3) moist; massive; soft, very friable; neutral.

The A horizon ranges from 6 to 14 inches in thickness and from dark grayish brown to brown. In most places it is fine sandy loam, but it is sandy loam in some places. It is medium acid or slightly acid. The B2t horizon ranges from dark grayish brown to light yellowish brown and from medium acid to neutral. It is sandy clay loam, loam, or heavy fine sandy loam that averages 18 to 27 percent clay. The C horizon is fine sandy loam or loamy fine sand in most places. It ranges from slightly acid to mildly alkaline. Free carbonates do not occur within a depth of 40 inches. More silty or more clayey strata occur in some places below a depth of 40 inches.

The temperature of Naron soils mapped in this county north and east of the Little Arkansas River is cooler than is defined in the range for the series. This difference does not alter the usefulness or behavior of the soils.

Naron soils are associated with Pratt, Carwile, and Farnum soils. They have a more clayey B2t horizon than Pratt soils and a less clayey B2t horizon than Carwile and Farnum soils.

Naron fine sandy loam, 0 to 1 percent slopes (Na).—This soil has a profile similar to the one described as representative of the series, but the surface layer averages about 2 inches thicker.

Included lower areas of Carwile fine sandy loam make up about 6 percent of the acreage of this soil, and lower areas of Farnum loam make up 4 percent.

Runoff is slow on this Naron soil, and most of the precipitation enters the soil. Soil blowing is a slight hazard. Stubble-mulch tillage and wind stripcropping help to control blowing.

This soil is well suited to irrigation and to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. A small acreage is in alfalfa. Capability unit I–3; Sandy range site; windbreak group 4.

Naron fine sandy loam, 1 to 4 percent slopes (Nb).—This gently undulating or gently sloping soil has slopes mostly of 1 to 4 percent, but slopes are as much as 6 percent in places. This soil has the profile described as representative of the series.

Included areas of Farnum loam make up about 3 percent of the acreage of this soil, lower areas of Carwile fine sandy loam make up 2 percent, and higher areas of Pratt loamy fine sand make up 7 percent.

The hazard of soil blowing and erosion is moderate on this Naron soil. Terraces, contour farming, and stubble-mulch tillage help to control erosion on gently sloping soils. On gently undulating soils where terraces are not feasible, wind stripcropping, stubble-mulch tillage, and shelterbelts help to control erosion. This soil is easily worked throughout a wide range of moisture conditions.

This soil is well suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum, a small acreage is in alfalfa, and the rest is in native grass. The soil is suited to sprinkler irrigation or leveling for flood irrigation. Capability unit IIe–3; Sandy range site; windbreak group 4.

Plevna Series

The Plevna series consists of deep, poorly drained, nearly level soils in low upland areas. These soils have a high water table. The upper part formed in loamy alluvial or eolian sediments; in many places these soils are more sandy below a depth of about 40 inches.

In a representative profile the surface layer is gray fine sandy loam 18 inches thick. The lower 9 inches has strong-brown mottles. The subsoil is light brownish-gray, friable fine sandy loam 24 inches thick. It has strong-brown mottles. The underlying material is light-gray fine sand mottled with reddish yellow.

Runoff is very slow. Permeability is moderately rapid above the water table, which is within a few inches of the surface during wet seasons and drops to a depth of about 4 feet during dry seasons. Fertility is medium, and the available water capacity is moderate.

Representative profile of Plevna fine sandy loam in an area of Dillwyn-Plevna complex, in native grass, 1,275 feet west and 175 feet south of the northeast corner of sec. 7, T. 23 S., R. 3 W.

A11—0 to 9 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) moist; common, yellowish-red (5YR 5/6), organic staining along root channels; weak, medium, granular structure; soft, very friable; medium acid; clear, smooth boundary.

A12—9 to 18 inches, gray (10YR 5/1) fine sandy loam, very dark grayish brown (10YR 3/2) moist; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, granular structure; soft, very friable; medium acid; gradual, smooth boundary.

B2g—18 to 42 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; common, medium, distinct, strong-brown (7.5YR 5/6) mottles above depth of 24 inches, many below that depth; weak, coarse, granular structure; slightly hard, friable; medium acid; gradual, smooth boundary.

IIC—42 to 60 inches, light-gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; common, medium, distinct, reddish-yellow (7.5YR 6/6) mottles; single grain; loose; medium acid.

The A1 horizon ranges from 10 to 24 inches in thickness. It is fine sandy loam in most places, but it is loamy fine sand in some areas. It ranges from very dark gray to grayish brown. In most places the lower part of the A horizon is mottled. The B horizon ranges from gray or grayish brown to light gray. Reaction throughout the soil is medium acid or slightly acid.

Plevna soils mapped in Harvey County are more acid than is defined in the range for the series. This difference does not alter the usefulness or behavior of the soils.

Plevna soils were mapped in a complex with Dillwyn soils. They are less sandy below the A horizon than Dillwyn soils.

Pratt Series

The Pratt series consists of deep, well-drained, gently undulating to hummocky soils on uplands. These soils formed in sandy eolian deposits.

In a representative profile the surface layer is brown loamy fine sand 12 inches thick. The subsoil is 18 inches thick. It is yellowish-brown, very friable loamy fine sand that is slightly more clayey than the surface layer. The underlying material is light yellowish-brown loamy fine sand.

Runoff is slow, and permeability is rapid. Fertility and available water capacity are low.

Representative profile of Pratt loamy fine sand, 1 to 5 percent slopes, in a formerly cultivated field reseeded to grass, 375 feet west and 200 feet north of the southeast corner of the NE¼ sec. 16, T. 23 S., R. 3 W.

A1—0 to 12 inches, brown (10YR 5/3) loamy fine sand, brown to dark brown (10YR 4/3) moist; weak, fine, granular structure; soft, very friable; slightly acid; clear, smooth boundary.

B2t—12 to 30 inches, yellowish-brown (10YR 5/4) loamy fine sand, dark yellowish brown (10YR 4/4) moist; weak, coarse, prismatic structure; soft, very friable; few horizontal bands, ¼ to ½ inch wide, of clay-coated sand grains; slightly acid; gradual, smooth boundary.

C—30 to 60 inches, light yellowish-brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/4) moist; single grain; loose; slightly acid.

The A horizon ranges from 8 to 18 inches in thickness and is loamy fine sand or fine sand. It ranges from dark grayish brown to pale brown and is medium acid or slightly acid. The B2t horizon ranges from dark grayish brown to light yellowish brown and from medium acid to neutral. It is 3 to 9 percent more clay than the A horizon. Free carbonates do not occur within a depth of 40 inches.

Pratt soils are associated with Tivoli, Carwile, Naron, and Farnum soils. They are more sandy throughout than Carwile, Naron, and Farnum soils. They have a B2t horizon that is lacking in Tivoli soils.

Pratt loamy fine sand, 1 to 5 percent slopes (Pa).—This undulating sandy soil has slopes that are mostly 1 to 5 percent, but in places slopes are as much as 8 percent. The profile is the one described as representative of the series.

Included areas of Carwile fine sandy loam make up about 7 percent of the acreage of this soil, lower areas of Farnum fine sandy loam and Naron fine sandy loam make up 3 percent, and higher areas of Tivoli loamy fine sand make up about 2 percent. Areas of a soil that is similar to Pratt soils, but has a fine sandy loam subsoil, make up about 5 percent of the acreage.

The hazard of soil blowing is severe. Stubble-mulch tillage, wind stripcropping, and shelterbelts help to control erosion.

This soil is suited to most crops and grasses commonly grown in the county. About half the acreage is used for wheat and sorghum and half is used for range. The soil is well suited to sprinkler irrigation. Capability unit IIIe–4; Sands range site; windbreak group 5.

Pratt-Carwile complex (0 to 5 percent slopes) (Pc).—This undulating to hummocky complex is on low uplands. It is about 60 percent Pratt loamy fine sand and about 40 percent Carwile fine sandy loam. The proportion of Pratt loamy fine sand ranges from 50 to 70 percent, and that of Carwile fine sandy loam ranges from 30 to 50 percent. Some areas are as much as 5 percent Dillwyn loamy fine sand. Side slopes of ridges are mostly 1 to 5 percent, but slopes are as much as 8 percent in places. Pratt loamy fine sand is on the ridges, and nearly level Carwile fine sandy loam is on areas between the ridges.

These soils are suited to most crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. Soil blowing is a hazard. Stubble-mulch tillage, wind stripcropping, and shelterbelts help to control blowing. Water stands on the Carwile soil for long periods after heavy rain. Tillage, planting, and harvesting often have to be delayed on these wet areas, and crops are drowned out in some years. Surface drainage improves crop growth and makes timely tillage possible. These soils are suitable for sprinkler irrigation or leveling for flood irrigation if drainage is adequate. Capability unit IIIe–4; Pratt soil in Sands range site and windbreak group 5; Carwile soil in Sandy range site and windbreak group 3.

Pratt-Tivoli loamy fine sands (5 to 15 percent slopes) (Pt).—This mapping unit is about 55 percent Pratt loamy fine sand, 35 percent Tivoli loamy fine sand, 5 percent Dillwyn loamy fine sand, and 5 percent Carwile fine sandy loam. The topography is hummocky. Slopes range from 5 to 15 percent. Tivoli loamy fine sand is on the crests of the ridges, and Pratt loamy fine sand is on the sides. Dillwyn loamy fine sand and Carwile fine sandy loam are on the lowest areas of the complex. The Dillwyn and Carwile soils are not in all areas of the complex. The Dillwyn and Carwile soils have the profiles described as representative of their respective series.

The Tivoli soil has an 8-inch surface layer of grayish-brown loamy fine sand. The next layer is brown loamy fine sand 8 inches thick, and the underlying material, between depths of 16 and 60 inches, is light yellowish-brown fine sand.

These soils are not suitable for crops, because they are so sandy and hummocky. They are used for range. Good management is needed to maintain enough vegetation to prevent soil blowing. Capability unit VIe–2; Sands range site; Pratt soil in windbreak group 5 and Tivoli soil in windbreak group 6.

Rosehill Series

The Rosehill series consists of moderately deep, well-drained, gently sloping or moderately sloping soils on uplands. These soils formed in residuum from clay shale.

In a representative profile the surface layer is dark-gray silty clay 9 inches thick. The next 9 inches is dark grayish-brown, very firm silty clay. The next 7 inches is grayish-brown, very firm silty clay that has a few light olive-brown mottles. The next 9 inches is light olive-brown silty clay mottled with olive yellow. Below this is light yellowish-brown clay shale.

Runoff is medium or rapid, and permeability is very slow. Fertility is medium, and the available water capacity is low.

Representative profile of Rosehill silty clay, 1 to 3 percent slopes, in a cultivated field, 785 feet west and 200 feet south of the northeast corner of the NW¼ sec. 1, T. 23 S., R. 2 E.

A1—0 to 9 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; weak, medium, granular structure; hard, firm; slightly acid; clear, smooth boundary.

AC1—9 to 18 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak, fine, blocky structure; very hard, very firm; neutral; gradual, smooth boundary.

AC2—18 to 25 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; few, fine, faint, light olive-brown (2.5Y 5/4) mottles; weak, fine, blocky structure; very hard, very firm; streaks of very dark grayish brown (10YR 3/2) along cracks; few lime concretions; moderately alkaline; gradual, smooth boundary.

C1—25 to 34 inches, light olive-brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; common, fine, faint, olive-yellow (2.5Y 6/6) mottles; massive; very hard, very firm; streaks of very dark grayish brown (2.5Y 3/2) along cracks; few, small, hard lime concretions; moderately alkaline; gradual, smooth boundary.

C2—34 to 50 inches, light yellowish-brown (2.5Y 6/4) consolidated clay shale, light olive brown (2.5Y 5/4) moist; noncalcareous; lime concretions and soft seams of lime; few, small gypsum crystals.

The A horizon ranges from 6 to 12 inches in thickness and is silty clay, heavy silty clay loam, or clay. It ranges from dark gray to grayish brown and is slightly acid or neutral. The AC horizon ranges from dark grayish brown or olive gray to very pale brown or pale yellow and from neutral to moderately alkaline. It is silty clay or clay that is 40 to 60 percent clay. The C horizon has the same color range as the AC horizon. It is mildly alkaline or moderately alkaline. Depth to the C2 horizon ranges from 22 to 40 inches.

Rosehill soils are associated with Irwin, Clime, and Goessel soils. They are shallower over shale than Irwin and Goessel soils and have a more clayey A1 horizon than Irwin soils. They are deeper over calcareous material than Clime soils.

Rosehill silty clay, 1 to 3 percent slopes (Ro).—This soil has the profile described as representative of the series.

Included areas of Clime silty clay make up about 6 percent of the acreage of this soil, and areas of Irwin silty clay loam 5 percent.

Runoff is medium on this Rosehill soil, and the hazard of erosion is severe. Terraces and contour farming help to control erosion. Good management of crop residue is needed to keep the surface layer porous and help prevent crusting. Tillage is limited to a narrow range of moisture conditions. Moisture is released slowly.

This soil is suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. Capability unit IIIe–3; Clay Upland range site; windbreak group 8.

Rosehill silty clay, 3 to 6 percent slopes (Rs).—Included areas of Clime silty clay make up about 6 percent of the acreage of this soil; and Irwin silty clay loam, 3 percent.

Runoff is rapid on this Rosehill soil, and much of the precipitation runs off. Tillage is limited to a narrow range of moisture conditions. Moisture is released slowly. The hazard of erosion is very severe in areas left bare of vegetation. Terraces and contour farming help to control erosion, and grasses and legumes in the rotation are beneficial. Good management of crop residue is needed to keep the surface layer porous and help prevent crusting.

This soil is not well suited to cultivated crops grown year after year because it is clayey and sloping. About half the acreage is used for wheat and sorghum, and the other half is in range. Capability unit IVe–1; Clay Upland range site; windbreak group 8.

Smolan Series

The Smolan series consists of deep, well-drained, gently sloping soils on uplands. These soils formed in loess or loamy old alluvium.

In a representative profile the surface layer is dark grayish-brown silty clay loam 10 inches thick. The subsoil is 40 inches thick. The upper 6 inches is brown to dark-brown, firm silty clay loam; the next 24 inches is brown to dark-brown, very firm silty clay; and the lower 10 inches is reddish-brown, firm silty clay. The underlying material is yellowish-red, weakly calcareous silty clay loam (fig. 11).

Runoff is medium, and permeability is slow. Fertility is medium, and the available water capacity is high.

Representative profile of Smolan silty clay loam, 1 to 3 percent slopes, in a cultivated field, 175 feet east and 65 feet south of the northwest corner of the SW¼ sec. 33, T. 22 S., R. 2 W.

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark brown (10YR 2/2) moist; moderate, medium, granular structure; slightly hard, friable; medium acid; clear, smooth boundary.

B1—10 to 16 inches, brown to dark-brown (7.5YR 4/2) heavy silty clay loam, dark brown (7.5YR 3/2) moist; moderate, fine, subangular blocky structure; hard, firm; slightly acid; clear, smooth boundary.

B21t—16 to 24 inches, brown to dark-brown (7.5YR 4/3) light silty clay, dark brown (7.5YR 3/3) moist; moderate, fine, blocky structure; very hard, very firm; neutral; gradual, smooth boundary.

B22t—24 to 40 inches, brown to dark-brown (7.5YR 4/3) silty clay, dark brown (7.5YR 3/3) moist; moderate, medium, blocky structure; very hard, very firm; neutral; gradual, smooth boundary.

B3—40 to 50 inches, reddish-brown (5YR 5/4) light silty clay, reddish brown (5YR 4/4) moist; weak, medium, blocky structure; very hard, firm; neutral; gradual, smooth boundary.

C—50 to 60 inches, yellowish-red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; massive; hard, firm; weakly calcareous; few seams and small concretions of lime; mildly alkaline.

The A horizon ranges from 7 to 14 inches in thickness. It is silty clay loam in most places, but it is heavy silt loam in a few places. It ranges from dark gray to brown and is medium acid or slightly acid. The B2t horizon ranges from brown or reddish brown to light brown or light reddish brown and from medium acid to neutral. It is silty clay or heavy silty clay loam that averages 35 to 50 percent clay. Depth to free carbonates ranges from 30 to more than 60 inches.

Smolan soils are associated with Crete and Geary soils. They have a redder B2t horizon than Crete soils and a more clayey B2t horizon than Geary soils.

Smolan silty clay loam, 1 to 3 percent slopes (Sm).—Included higher areas of Crete silt loam make up about 5 percent of the acreage of this soil; lower, more convex areas of Geary silt loam make up 3 percent; and areas of Hobbs silt loam along drainageways make up about 2 percent.

The hazard of erosion is moderate on the Smolan soil. Terraces and contour farming help to control erosion.

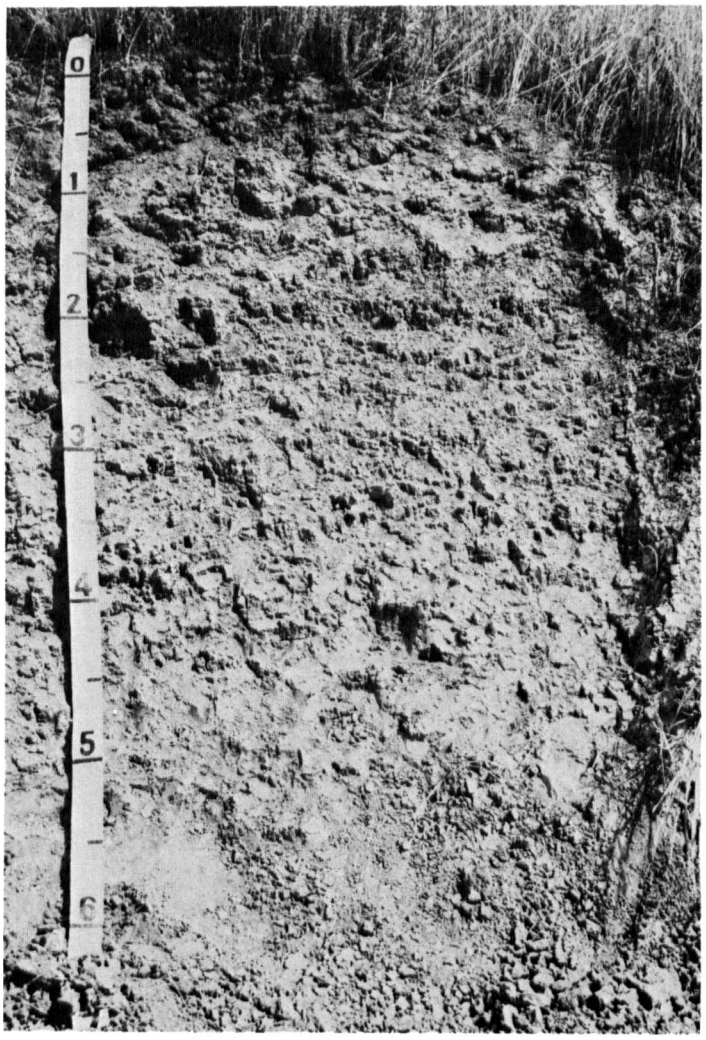

Figure 11.—**Profile of Smolan silty clay loam.**

Keeping crop residue at or near the surface helps improve soil tilth, the supply of organic matter, and moisture penetration.

This soil is well suited to all crops and grasses commonly grown in the county. Most of the acreage is used for wheat and sorghum. Capability unit IIe–2; Loamy Upland range site; windbreak group 2.

Tivoli Series

The Tivoli series consists of deep, excessively drained, hummocky and duny soils on uplands. These soils formed in sandy eolian sediments.

In a representative profile the surface layer is brown fine sand 7 inches thick. The underlying material is light yellowish-brown fine sand.

Runoff is very slow, and permeability is rapid. Fertility and available water capacity are low.

Representative profile of Tivoli fine sand, in native grass, 375 feet south and 100 feet west of the northeast corner of sec. 8, T. 23 S., R. 3 W.

A1—0 to 7 inches, brown (10YR 5/3) fine sand, brown to dark brown (10YR 4/3) moist; single grain; loose; many fine roots; slightly acid; gradual, smooth boundary.

C—7 to 60 inches, light yellowish-brown (10YR 6/4) fine sand, yellowish brown (10YR 5/4) moist; single grain; loose; few fine roots in upper 6 inches; slightly acid.

The A horizon ranges from 4 to 10 inches in thickness and is fine sand or loamy fine sand. It ranges from grayish brown to light yellowish brown and is slightly acid or neutral. The C horizon ranges from brown to very pale brown and from slightly acid to mildly alkaline.

Tivoli soils are associated with Pratt and Dillwyn soils. They do not have the B2t horizon of Pratt soils or the mottles of Dillwyn soils. They are excessively drained, whereas Dillwyn soils are somewhat poorly drained.

Tivoli fine sand (15 to 25 percent slopes) (Tv).—This soil is hummocky to duny. It has the profile described as representative of the series.

Included areas of Pratt loamy fine sand make up about 10 percent of the acreage of this soil, and areas of Dillwyn loamy fine sand make up 5 percent. Small blowouts are shown on the soil map by spot symbols.

This Tivoli soil absorbs most of the precipitation, and no drainage pattern has been established. Soil blowing is a hazard in areas where native grasses are grazed too short.

This soil is used for range. It is too steep and too sandy for cultivation. Capability unit VIIe–1; Choppy Sands range site; windbreak group 6.

Use and Management of the Soils

The soils of Harvey County are used mostly for dryland farming and range. Minor acreages in the northwestern and southwestern parts of the county and along the Little Arkansas River and Sand Creek are irrigated. Almost half the total acreage is nearly level soils that have a surface layer of fine sandy loam to silty clay. These nearly level soils are, for the most part, subject to only slight erosion. The soils that have a surface layer of fine sandy loam are subject to blowing unless protected by crops, plant residue, or windbreaks. The rest of the acreage of the county is soils that have slopes of 1 to 15 percent. All of these soils are subject to erosion. Almost all areas where slopes are more than 6 percent are in native grass, and many where slopes are less than 6 percent are also in grass.

This section explains the system of classifying soils according to suitability for field crops and pasture; gives predicted yields of wheat and grain sorghum at a high level of management; describes the range sites; and discusses use of the soils for windbreaks, wildlife habitat, recreation, and engineering.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of farming. The soils are grouped according to their limitation when used for field crops, the risk of damage when they are farmed, and the way they respond to treatment. The grouping does not take into account major and generally expensive

landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, although they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–3 or IIIe–6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

For a complete explanation of the capability classification, see Department of Agriculture Handbook 210 (*7*).

The eight classes in the capability system and the subclasses and units in Harvey County are described in the list that follows. The capability classification of each soil is given in two places in this publication: at the end of the soil description and in the "Guide to Mapping Units." Discussions of use and management of the soils for field crops and pasture are included in the individual soil descriptions under the heading "Descriptions of the Soils."

Class I. Soils have few limitations that restrict their use.
- Unit I–1. Deep, nearly level loams and silt loams.
- Unit I–2. Deep, nearly level silty clay loams.
- Unit I–3. Deep, nearly level fine sandy loams.

Class II. Soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe–1. Deep, gently sloping loams and silt loams.
  - Unit IIe–2. Deep, gently sloping silt loams and silty clay loams.
  - Unit IIe–3. Deep, gently sloping fine sandy loams.
- Subclass IIw. Soils have a moderate hazard of flooding or wetness.
  - Unit IIw–1. Deep, nearly level silt loams and loams.
  - Unit IIw–2. Deep, nearly level fine sandy loams.
- Subclass IIs. Soils have a moderate limitation of poor tilth or moisture penetration.
  - Unit IIs–1. Deep, nearly level silty clay loams and silty clays.
  - Unit IIs–2. Deep, nearly level silt loams.

Class III. Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIe–1. Deep, gently sloping silty clay loams and silty clays.
  - Unit IIIe–2. Deep, moderately sloping loams and silt loams.
  - Unit IIIe–3. Moderately deep, gently sloping silty clays.
  - Unit IIIe–4. Deep, gently undulating loamy fine sands and fine sandy loams.
  - Unit IIIe–5. Deep, gently sloping clay loams.
  - Unit IIIe–6. Deep, moderately sloping silty clay loams.
- Subclass IIIw. Soils are severely limited by excessive wetness.
  - Unit IIIw–1. Moderately deep, nearly level loams.

Class IV. Soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe–1. Moderately deep, moderately sloping silty clays.
  - Unit IVe–2. Deep, moderately sloping silty clay loams.
- Subclass IVs. Soils have a very severe limitation of poor tilth or salt accumulation.
  - Unit IVs–1. Deep, nearly level loams and silty clay loams and Slickspots.

Class V. Soils are not likely to erode but have other

limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.

Subclass Vw. Soils too wet for cultivation.

Unit Vw–1. Deep, nearly level loamy fine sands and fine sandy loams.

Unit Vw–2. Deep, nearly level loams.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Subclass VIe. Soils severely limited by risk of erosion if protective cover is not maintained.

Unit VIe–1. Deep, nearly level to hummocky loamy fine sands and fine sands.

Unit VIe–2. Deep, hummocky loamy fine sands.

Unit VIe–3. Sloping to steep sides and narrow bottoms of intermittent drainageways.

Unit VIe–4. Moderately deep, moderately sloping or sloping silty clays.

Class VII. Soils have very severe limitations that make them unsuitable for cultivation and restrict their use to pasture or range, woodland, or wildlife.

Subclass VIIe. Soils very severely limited by risk of erosion if protective cover is not maintained.

Unit VIIe–1. Deep, hummocky to duny fine sands.

Subclass VIIw. Soils very severely limited by excessive wetness.

Unit VIIw–1. Deeply entrenched stream channels that have steep, broken side slopes.

Class VIII. Soils and landforms have limitations that preclude their use for commercial crop production without major reclamation and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. No class VIII soils are in Harvey County.

Predicted Yields [2]

Table 2 gives the predicted average yields per acre of the principal crops, wheat and grain sorghum, grown on the arable soils of Harvey County in capability classes I, II, III, and IV. The yields shown are for a high level of management. They are based mainly on information gathered from interviews with farmers and information obtained from the county extension agent and other professional farm workers.

High level management provides—

1. Recommended crop varieties adapted to the area.
2. Proper seeding rates, dates, and methods of plant- and efficient harvesting.
3. Weed, insect, and disease control.
4. Enough fertilizer and lime for maximum yields.
5. Terraces and grassed waterways and farming on the contour where needed and other practices that conserve moisture and help to control erosion.
6. Use of crop residue to control soil blowing and erosion, increase the infiltration of water, and encourage the emergence of seedlings.
7. A cropping system that fits the needs of the operator and keeps the soil in good condition.

[2] EARL J. BONDY, conservation agronomist, Soil Conservation Service, helped prepare this section.

TABLE 2.—*Predicted average yields per acre of wheat and grain sorghum under high level management*

[Only the soils of capability classes I, II, III, and IV are listed]

Soil	Wheat	Grain sorghum
	Bu.	*Bu.*
Carwile fine sandy loam	26	50
Clark clay loam, 1 to 3 percent slopes	30	46
Clime silty clay, 1 to 3 percent slopes	32	44
Clime silty clay, 3 to 6 percent slopes	28	40
Crete silt loam, 0 to 1 percent slopes	42	68
Crete silt loam, 1 to 3 percent slopes	40	64
Detroit silty clay loam	42	70
Farnum fine sandy loam, 0 to 1 percent slopes	38	68
Farnum loam, 0 to 1 percent slopes	40	70
Farnum loam, 1 to 3 percent slopes	38	66
Farnum loam, 3 to 6 percent slopes	36	62
Farnum-Slickspots complex	28	40
Geary silt loam, 0 to 1 percent slopes	42	72
Geary silt loam, 1 to 3 percent slopes	40	70
Geary silt loam, 3 to 6 percent slopes	38	66
Goessel silty clay, 0 to 1 percent slopes	36	56
Goessel silty clay, 1 to 2 percent slopes	34	52
Hobbs silt loam	40	68
Irwin silty clay loam, 1 to 3 percent slopes	36	52
Irwin silty clay loam, 3 to 6 percent slopes	34	48
Irwin silty clay loam, 2 to 6 percent slopes, eroded	26	42
Kaski loam	42	68
Ladysmith silty clay loam, 0 to 1 percent slopes	36	56
Ladysmith silty clay loam, 1 to 2 percent slopes	34	54
Ladysmith-Slickspots complex	24	36
Lesho loam	30	52
Naron fine sandy loam, 0 to 1 percent slopes	36	66
Naron fine sandy loam, 1 to 4 percent slopes	34	62
Pratt loamy fine sand, 1 to 5 percent slopes	28	50
Pratt-Carwile complex	28	50
Rosehill silty clay, 1 to 3 percent slopes	32	46
Rosehill silty clay, 3 to 6 percent slopes	28	40
Smolan silty clay loam, 1 to 3 percent slopes	38	60

Management of Range [3]

Much of the farm income in Harvey County is from the sale of beef cattle, sheep, and dairy products. The number of cattle, including calves, in the county usually is between 42,000 and 52,000. The number of sheep varies between 17,500 and 32,000.

The major source of livestock feed is native range, but large amounts of crops and their byproducts are used for supplemental feed. Large areas of range are in the eastern one-fourth of the county and in the sandhills in the western part. Smaller areas of range are scattered throughout the county.

In addition to producing pasture and hay for livestock, range provides food and cover for wildlife. Well-managed range contributes to flood control because a large amount of the precipitation that falls soaks into the root zone.

Effective range management requires knowledge of the capabilities of the various soils, the combinations of plants that can be produced, and the effects of grazing on the different kinds of plants. It also requires the

[3] HARLAND E. DIETZ, range conservationist, Soil Conservation Service, helped prepare this section.

ability to recognize signs of improvement or deterioration of range vegetation. A system for inventorying and evaluating range resources is discussed in the following paragraphs.

Range sites and condition classes

A range site is a distinctive area of rangeland that, because of its particular combination of soils, climate, and topography, produces a particular kind and amount of native vegetation. Since there are no significant differences in climate and elevation within Harvey County, differences in such soil characteristics as depth, texture, and salinity or differences in topography are the bases for grouping soils into range sites. Each range site produces a characteristic type of climax vegetation, and usually each site needs a particular system of management to keep it productive.

Climax vegetation is considered the most productive combination of plants that will maintain itself on a range site under natural climatic conditions. Continuous excessive grazing alters this original plant cover and lowers productivity. Livestock graze selectively, constantly seeking the more palatable plants. Unless grazing is regulated, the better plants weaken and gradually decrease in abundance; consequently, this group of plants is referred to as *decreasers*. *Increasers* are plants that begin to spread when the decreasers begin to decline. These plants are usually less productive and less palatable for grazing. If heavy grazing continues, even the increaser plants weaken and decline in abundance. They are replaced by less desirable grasses and weeds that are not members of the climax community, which are called *invaders*.

Range condition is the present state of vegetation of a range site in relation to the climax plant community for that site. As the vegetation on a range site changes from predominantly decreaser to increaser and invader plants, the productivity and general health of the range decline. To indicate the degree to which a range has deteriorated from its potential, the following four classes of range condition are recognized: excellent, good, fair, and poor.

Excellent means that 76 to 100 percent of the present vegetation is of the same composition as the original vegetation. Decreaser plants dominate, and forage production is near the maximum for the site. The plant cover encourages intake of moisture and provides excellent protection against erosion.

Good means that 51 to 75 percent of the present vegetation is of the same composition as the original vegetation. A few decreaser plants have been grazed out and replaced by increaser plants, but the general productivity of the site is still good.

Fair means that 26 to 50 percent of the present vegetation is of the same composition as the original vegetation. With increaser plants dominant and weedy plants invading, production of palatable forage is well below the potential for the site.

Poor means that less than 25 percent of the present vegetation is of the same composition as the original vegetation. Invaders and increasers are abundant, and very few decreasers remain. Production is unsatisfactory.

Range in poor or fair condition should be improved, and range in good and excellent condition should be maintained. This is accomplished primarily through recognition of the range site, determination of range condition, and regulation of grazing to encourage growth of the better climax forage plants.

Descriptions of the range sites

The soils of Harvey County have been grouped into range sites according to their ability to produce similar kinds and amounts of climax vegetation. The description of each range site gives the more important characteristics of the soils, estimates of potential yields, and the names of the principal decreaser, increaser, and invader plants. The names of the series represented are given at the beginning of the description of each range site, but the listing of the series name does not necessarily mean that all soils of that series are in the same range site. The range site classification of each individual soil is given in two places in this publication: at the end of the soil description and in the "Guide to Mapping Units."

CHOPPY SANDS RANGE SITE

Tivoli fine sand is the only soil in this range site. This soil is deep, hummocky to duny, and excessively drained. It is fine sand throughout.

The climax plant cover on this site is chiefly a mixture of decreaser grasses, including sand bluestem, little bluestem, sand lovegrass, switchgrass, and big sandreedgrass. These grasses make up at least 70 percent of the total plant production.

The principal increasers include sand dropseed, sand paspalum, sandplum, and small soapweed. Common invaders are sandbur, red lovegrass, camphorweed, western ragweed, and annual eriogonum.

If this site is in excellent condition, the average annual yield of air-dry herbage is 4,000 pounds per acre in favorable years and 2,000 pounds per acre in unfavorable years.

CLAY LOWLAND RANGE SITE

The Ladysmith part of Ladysmith-Slickspots complex is the only soil in this range site. This soil is deep, nearly level, and moderately well drained. It has a surface layer of silty clay loam and a subsoil of silty clay. It receives extra moisture through flooding but tends to be droughty during dry periods.

The climax plant cover on this site is chiefly a mixture of decreaser grasses, including prairie cordgrass, eastern gamagrass, indiangrass, switchgrass, Canada wildrye, and big bluestem. These grasses make up at least 60 percent of the total plant production.

Western wheatgrass, tall dropseed, vine-mesquite, knotroot bristlegrass, and side-oats grama are among the principal increasers. Common woody plants that increase on this site are elm, hackberry, buttonbush, cottonwood, and coralberry. Plants that invade the site under prolonged overgrazing are saltgrass, buffalograss, silver bluestem, ironweed, and western ragweed.

If this site is in excellent condition, the average annual yield of air-dry herbage is 8,000 pounds per acre in favorable years and 4,000 pounds per acre in unfavorable years.

CLAY UPLAND RANGE SITE

This range site consists of soils of the Goessel, Irwin, Ladysmith, and Rosehill series and the Breaks part of

Breaks-Alluvial land complex. These are moderately deep and deep, nearly level to sloping, moderately well drained and well drained soils. They have a surface layer of silty clay loam or silty clay and a subsoil of silty clay or clay. If rainfall is below normal, they are droughty.

The climax plant cover on this site is chiefly a mixture of decreaser grasses, including big bluestem, little bluestem, indiangrass, and switchgrass. These grasses make up at least 50 percent of the total plant production, and other perennial grasses and forbs make up the rest.

Western wheatgrass, blue grama, buffalograss, heath aster, and goldenrod increase under prolonged heavy grazing. Broomweed, annual three-awn, western ragweed, tumblegrass, Kentucky bluegrass, and buckbrush invade the site if overgrazing continues.

If this site is in excellent condition, the average annual yield of air-dry herbage is 4,500 pounds per acre in favorable years and 2,000 pounds per acre in unfavorable years.

LIMY UPLAND RANGE SITE

This range site consists of soils of the Clark and Clime series. These are moderately deep and deep, gently sloping to moderately sloping, well-drained soils. They are typically clay loam or silty clay throughout. Depth to lime is less than 10 inches.

The climax plant cover on this site is a mixture of decreaser grasses, shrubs, and forbs. Decreaser plants make up at least 80 percent of the total plant production and include big bluestem, little bluestem, indiangrass, and switchgrass. Important legumes and forbs are leadplant, roundhead prairie clover, catclaw sensitivebrier, jerseytea, and black samson.

Important increasers include side-oats grama, blue grama, tall dropseed, and Missouri goldenrod. Common invaders are silver bluestem, windmillgrass, western ragweed, and annual broomweed.

If this site is in excellent condition, the average annual yield of air-dry herbage is 5,000 pounds per acre in favorable years and 3,000 pounds per acre in unfavorable years.

LOAMY LOWLAND RANGE SITE

This range site consists of soils of the Detroit, Hobbs, and Kaski series and the Alluvial land part of Breaks-Alluvial land complex. These are deep, nearly level, well drained and moderately well drained soils. They have a surface layer of loam, silt loam, or silty clay loam and a subsoil of clay loam, silt loam, silty clay loam, or silty clay. They receive extra moisture as runoff or floodwater.

The climax plant cover on this site is chiefly a mixture of warm-season decreaser grasses, including big bluestem, indiangrass, switchgrass, eastern gamagrass, and prairie cordgrass. These grasses make up 70 to 90 percent of the total plant production.

Trees, mainly elm, cottonwood, willow, and hackberry, have invaded areas along streambanks. Under the canopy of these trees are Canada wildrye, Virginia wildrye, and other shade-tolerant, cool-season grasses. Overgrazing causes an increase in these woody plants and in such grasses as western wheatgrass, tall dropseed, and purpletop. Common invaders are ironweed, western ragweed, buffalograss, and silver bluestem.

If this site is in excellent condition, the average annual yield of air-dry herbage is 9,000 pounds per acre in favorable years and 5,000 pounds per acre in unfavorable years.

LOAMY UPLAND RANGE SITE

This range site consists of soils of the Crete, Farnum, Geary, and Smolan series. These are deep, nearly level to moderately sloping, moderately well drained and well drained soils. They have a surface layer of loam, silt loam, or silty clay loam and a subsoil of clay loam, silty clay loam, or silty clay.

The climax plant cover on this site is chiefly a mixture of decreaser grasses, including little bluestem, big bluestem, indiangrass, and switchgrass. These grasses make up at least 70 percent of the total plant cover, and other perennial grasses and forbs make up the rest.

The principal increaser grasses are blue grama, side-oats grama, tall dropseed, and buffalograss. Forbs that commonly increase on this site include Missouri goldenrod, ironweed, slimflower scurfpea, and western ragweed. The more common invaders are annual three-awn, annual brome, windmillgrass, silver bluestem, and broomweed.

If this site is in excellent condition, the average annual yield of air-dry herbage is 6,000 pounds per acre in favorable years and 4,000 pounds per acre in unfavorable years.

SALINE LOWLAND RANGE SITE

This range site consists of soils of the Drummond series and the Slickspots part of Farnum-Slickspots complex and Ladysmith-Slickspots complex. These are deep, nearly level, moderately well drained and somewhat poorly drained soils that have a variable amount of sodium in the subsoil. They have a surface layer of silt loam, loam, clay loam, or silty clay loam and a subsoil of clay loam, silty clay loam, or silty clay. In some areas the water table fluctuates between depths of 5 and 10 feet, which benefits the growth of deep-rooted plants.

The climax plant cover on this site is a mixture of such salt-tolerant grasses as switchgrass, alkali sacaton, western wheatgrass, tall dropseed, prairie cordgrass, vinemesquite, and saltgrass. These grasses make up at least 80 percent of the total vegetation.

Under prolonged overgrazing, alkali sacaton, tall dropseed, and salt grass increase, along with buffalograss and blue grama. Common invaders are kochia, alkali muhly, Japanese brome, and western ragweed.

If this site is in excellent condition, the average annual yield of air-dry herbage is 4,000 pounds per acre in favorable years and 2,000 pounds per acre in unfavorable years.

SANDS RANGE SITE

This range site consists of soils of the Pratt and Tivoli series. These are deep, undulating to hummocky, well-drained and excessively drained soils. They are loamy fine sand or fine sand.

The climax plant cover on this site is chiefly a mixture of decreaser grasses, including sand bluestem, little bluestem, indiangrass, switchgrass, and sand lovegrass. These grasses make up at least 70 percent of the total plant production, and other perennial grasses, forbs, and shrubs make up the rest.

Principal increasers are sand dropseed, fall witchgrass, prairie sagewort, sand paspalum, and sandplum. Com-

mon invaders are sandbur, annual eriogonum, camphorweed, and western ragweed.

If this site is in excellent condition, the average annual yield of air-dry herbage is 5,000 pounds per acre in favorable years and 3,000 pounds per acre in unfavorable years.

SANDY RANGE SITE

This range site consists of soils of the Carwile, Farnum, and Naron series. These are deep, nearly level to gently sloping, somewhat poorly drained and well-drained soils. They have a surface layer of fine sandy loam and a subsoil of sandy clay loam, clay loam, or clay.

The climax plant cover on this site is chiefly a mixture of such decreaser grasses as big bluestem, little bluestem, switchgrass, and indiangrass. These grasses make up at least 80 percent of the total plant production. Important decreaser forbs on this site are leadplant, pitchers sage, prairie clover, and Virginia tephrosia.

Blue grama, purple lovegrass, sand dropseed, tall dropseed, Scribners panicum, side-oats grama, prairie sagewort, and goldenrod replace the decreasers when the site is repeatedly overgrazed. Common invaders are broomweed, western ragweed, annual three-awn, and silver bluestem.

If this site is in excellent condition, the average annual yield of air-dry herbage is 5,500 pounds per acre in favorable years and 4,000 pounds per acre in unfavorable years.

SUBIRRIGATED RANGE SITE

This range site consists of soils of the Dillwyn, Lesho, and Plevna series. These are nearly level, somewhat poorly drained and poorly drained soils. They range from clay loam to fine sand in the upper 5 feet. The water table ranges from near the surface to a depth of about 5 feet and is within reach of plant roots during most of the growing season.

The climax plant cover on this site is chiefly a mixture of decreaser grasses, including indiangrass, big bluestem, prairie cordgrass, eastern gamagrass, and switchgrass. These grasses make up at least 80 percent of the total plant production.

Plants that increase under prolonged heavy grazing are western wheatgrass, knotroot bristlegrass, meadow dropseed, and sedges. Woody plants that increase with overgrazing include willow, cottonwood, buttonbush, and indigobush. Common invaders are western ragweed, ironweed, foxtail barley, elm, and Russian-olive.

If this site is in excellent condition, the average annual yield of air-dry herbage is 9,000 pounds per acre in favorable years and 7,000 pounds per acre in unfavorable years.

Management of Windbreaks[4]

Harvey County has no native woodland, but some trees have invaded the grasslands along streams and in the sandhills. Most of the soils will support trees. Trees are planted mainly as farmstead and field windbreaks, to be cut for Christmas trees, to provide shade, and for beautification. The plantings provide excellent wildlife habitat at many locations within the county.

Kinds of Windbreaks

There are two kinds of windbreaks in Harvey County. Farmstead windbreaks, the first kind, are planted around farmsteads, corrals, and feedyards to protect these areas from cold winter winds. If designed properly, farmstead windbreaks also control snow drifts and keep them out of the farmyard and livestock corrals. The wind-chill index is greatly influenced by a good farmstead windbreak. The fuel bill in the farm home can be reduced and the area surrounding the farmyard made more attractive.

Field windbreaks, the second kind, are most effective when planted in belts, one or more rows wide, across the field to protect soils that are subject to blowing. The belts should be planted 10 to 40 rods apart, depending on the blowing hazard. In certain years crop yields may be increased because blast damage from hot winds is prevented and mechanical damage to the crop is reduced. In some years crop yields are reduced next to the windbreak, because the trees use moisture needed by the crop.

[4] By F. DEWITT ABBOTT, State resource conservationist, Soil Conservation Service.

TABLE 3.—*Windbreak planting*

[Estimates of height are for 20-year-old trees. Vigor ratings are explained

Species	Group 1		Group 2		Group 3		Group 4	
	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height
		Ft.		*Ft.*		*Ft.*		*Ft.*
Eastern redcedar	Excellent	22	Excellent	25	Excellent	25	Excellent	24
Ponderosa pine	Fair to good	17	Fair to good	19	Fair to good	25	Good	25
Green ash	Poor		Poor		Good	28	Fair	26
Cottonwood	Poor		Poor		Good	53	Fair	40
Siberian elm	Fair	25	Good	44	Excellent	46	Good	44
Hackberry	Poor		Good	22	Good	25	Good	27
Honeylocust	Poor		Fair	22	Fair	22	Good	35
Mulberry	Poor		Fair	15	Good	22	Good	28
Osage-orange	Good	17	Excellent	19	Excellent	22	Excellent	22
Russian-olive	Poor		Poor		Poor		Fair	18

Planting and care of windbreaks

Windbreaks should be carefully planned and staked before the trees are planted. Select species of trees and shrubs that are best adapted to the soils, and prepare a good seedbed before the trees are planted. On most soils in Harvey County, areas to be planted to windbreaks should be prepared in the same way as for field crops.

Plant early in spring, and protect the seedlings from drying out while they are planted. As tree and shrub seedlings are planted, soil should be firmly tamped around the roots.

Young trees need considerable care if they are to grow well on the soils of Harvey County. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivate the windbreak as often as necessary to control weeds and reduce competition for soil moisture.

Windbreaks must be protected from livestock. Protection from fire is important and can be done by continuous cultivation for weed control around the outer margin of the windbreak. Rabbits and mice sometimes chew the bark and girdle young trees in a windbreak. Use a recommended repellent to control rodents.

Windbreak groups

Successful survival and growth of trees in the Central Great Plains are influenced to a great extent by the nature of the soil and by the soil-air-moisture relationship. Trees normally grow best on sandy loams. They make only fair to poor growth on clayey soils, because moisture is absorbed and released slowly by clay. Very sandy soils are not well suited to trees, because they do not store enough water and plant nutrients.

The soils of Harvey County have been placed in nine windbreak groups. Each group consists of soils that are suitable for about the same kinds of trees, require similar management, and provide about the same chance of survival and rate of growth. The windbreak classification of each soil is given in the "Guide to Mapping Units" and at the end of the soil description. Table 3 shows the relative suitability of selected species for planting on the soils of each windbreak group.

In windbreak group 1 are deep soils that have a surface layer of silty clay loam or silty clay and a subsoil of silty clay. In windbreak group 2 are deep soils that have a surface layer of loam, silt loam, clay loam, or silty clay loam and a subsoil of silty clay loam, clay loam, or silty clay. In windbreak group 3 are deep soils that have a surface layer of fine sandy loam and a subsoil of clay. In windbreak group 4 are deep soils that have a surface layer of fine sandy loam and a subsoil of clay loam or sandy clay loam. In windbreak group 5 are deep soils that consist of loamy fine sand throughout. In group 6 are deep soils that have a surface layer of loamy fine sand or fine sand and underlying material of fine sand. In group 7 are deep and moderately deep soils that have a surface layer of loam, silt loam, or silty clay loam and a subsoil of silt loam, loam, clay loam, silty clay loam, or silty clay. In group 8 are moderately deep soils that are silty clay throughout. In group 9 are poorly drained and somewhat poorly drained soils and saline-alkali soils. The soils of groups 1, 2, 3, 4, 5, 6, and 8 are on uplands; those of groups 7 and 9 are on lowlands.

A vigor rating of *excellent* in table 3 indicates that trees grow well, leaves have good color, there are no dead branches in the upper part of the crown, and there is no indication of damage by fungi or insects. A rating of *good* indicates that trees grow moderately well, a few dead branches and some dieback are in the upper part of the crown, and there is slight damage by fungi or insects. A rating of *fair* indicates at least half the trees have a significant number of dead branches in the upper part of the crown, about one-fourth of the trees in the stand are dead, tree growth is slow, and damage by fungi or insects is moderate. A rating of *poor* indicates that surviving trees have severe dieback, more than one-fourth of the trees in the stand are dead, and severe damage by fungi or insects can be expected.

Fish and Wildlife [5]

Suitability of the soils as wildlife habitat coincides generally with the pattern of the soil associations (see

[5] By JACK W. WALSTROM, biologist, Soil Conservation Service.

guide, by windbreak groups

in the text. No estimate of height is given if vigor is rated poor]

Group 5		Group 6		Group 7		Group 8		Group 9	
Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height
	Ft.		*Ft.*		*Ft.*		*Ft.*		*Ft.*
Excellent	19	Excellent	18	Excellent	30	Good	20	Poor	
Good	26	Good	20	Excellent	30	Fair	16	Poor	
Fair	22	Poor		Good	40	Poor		Poor	
Poor to good	45	Poor		Excellent	50	Poor		Poor	
Fair	36	Poor		Excellent	50	Fair	23	Poor	
Fair	18	Poor		Excellent	35	Poor		Poor	
Fair	28	Poor		Good	40	Poor		Not suited	
Fair to good	24	Poor		Excellent	35	Poor		Poor	
Good	12	Poor		Excellent	25	Fair	16	Poor	
Fair	15	Poor		Good	25	Poor		Fair	15

section "General Soil Map"). Table 4 shows the potential of each of the eight associations in Harvey County for providing habitat for each of four general groups of wildlife: openland wildlife, woodland wildlife, wetland wildlife, and fish.

Openland wildlife includes birds and mammals that normally frequent cropland, pastures, meadows, lawns, and areas overgrown with grasses, herbs, and shrubs. Examples are quail, pheasant, meadowlarks, field sparrows, red-winged blackbirds, cottontail rabbits, and ground squirrels.

Woodland wildlife includes birds and mammals that normally frequent wooded areas of hardwood trees and shrubs, coniferous trees and shrubs, or mixtures of these plants. Examples are thrushes, vireos, fox squirrels, red fox, white-tailed deer, mule deer, raccoon, and turkey.

Wetland wildlife includes birds and mammals that normally frequent ponds, streams or ditches, marshes, and swamps. Examples are wood ducks, rails, herons, shore birds, mink, muskrat, beaver, mallards, and pintails.

Of the openland group, ringnecked pheasants are most numerous in associations 1, 3, 6, 7, and 8. Bobwhite quail are to be found in all associations but are most numerous in associations 2 and 5.

Of the woodland groups, deer are most numerous in association 5. White-tailed deer are more common than mule deer. Association 5 also provides habitat for thrashers, cardinals, orioles, warblers, flycatchers, and other birds.

Of the wetland group, waterfowl and muskrat are most plentiful in associations 2, 4, and 8. Association 5 supports good populations of beaver, mink, and raccoon, in addition to waterfowl and muskrat.

Streams and farm ponds in the county provide good to excellent fishing. Bass, bluegill, channel catfish, flathead catfish, bullhead, and crappie are the common game fish.

Further information and assistance in planning and developing wildlife habitat can be obtained at the local office of the Soil Conservation Service and from the Forestry, Fish and Game Commission; the Bureau of Sport Fisheries and Wildlife; and the County Extension Agent.

Management for Recreation

Recreational developments should be planned so as to avoid or eliminate as many problems as possible. Information about the soils is basic to the development of any outdoor recreational facilities. Table 5 shows the degree of limitation of the various soils in Harvey County for the recreational uses described in the following paragraphs.

[6] By JACK W. WALSTROM, biologist, Soil Conservation Service.

TABLE 4.—*Potential of soil associations for providing habitat for four main groups of wildlife*

Soil association	Wildlife group	Potential for producing—			
		Woody cover	Herbaceous cover	Aquatic habitat	Food
1. Crete-Ladysmith	Openland		Good		Good.
	Woodland	Fair	Good		Fair.
	Wetland		Good	Fair	Fair.
	Fish			Fair	Fair.
2. Dillwyn-Tivoli	Openland		Good		Fair.
	Woodland	Fair	Good		Fair.
	Wetland		Good	Good	Good.
	Fish			Fair	Fair.
3. Carwile-Pratt	Openland		Good		Fair.
	Woodland	Fair	Good		Fair.
	Wetland		Good	Very poor	Fair.
	Fish			Very poor	Very poor.
4. Farnum-Slickspots-Naron	Openland		Fair		Fair.
	Woodland	Poor	Fair		Fair.
	Wetland		Good	Good	Good.
	Fish			Fair	Fair.
5. Detroit-Hobbs	Openland		Good		Good.
	Woodland	Good	Good		Good.
	Wetland	Fair	Good	Fair	Fair.
	Fish			Good	Fair.
6. Ladysmith-Goessel	Openland		Good		Fair.
	Woodland	Fair	Fair		Fair.
	Wetland		Fair	Fair	Fair.
	Fish			Fair	Fair.
7. Farnum-Hobbs-Geary	Openland		Good		Good.
	Woodland	Good	Good		Good.
	Wetland	Good	Good	Good	Good.
	Fish			Fair	Fair.
8. Irwin-Rosehill-Clime	Openland		Good		Fair.
	Woodland	Fair	Fair		Fair.
	Wetland	Fair	Fair	Good	Fair.
	Fish			Good	Fair.

TABLE 5.—*Limitations of soils for recreational uses*

[An asterisk before the series name in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. Since the different soils may have different properties and degrees of limitation, it is important to follow the instructions for referring to other series]

Soil series and map symbols	Campsites	Picnic areas	Intensive play areas	Trails and paths
Alluvial land, broken: Ad.	Severe: flooding	Severe: flooding	Severe: flooding and slope.	Moderate: flooding.
Breaks-Alluvial land complex: Ba.	Severe: flooding and fine texture.	Severe: flooding and fine texture.	Severe: flooding and slope.	Severe: fine texture.
Carwile: Ca	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Clark: Cc	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.
Clime: Cd, Ce, Cf, Cm	Severe: fine-textured surface layer.	Severe: fine-textured surface layer.	Severe: fine-textured surface layer.	Severe: fine-textured surface layer.
Crete: Cr, Ct	Moderate: slow permeability.	Slight	Moderate: slow permeability.	Slight.
Detroit: De	Severe: flooding	Moderate: flooding	Moderate: flooding	Moderate: moderately fine textured surface layer.
*Dillwyn: Dp, Dt. For Plevna part of Dp, see Plevna series. For Tivoli part of Dt, see Tivoli fine sand.	Severe: wetness	Severe: wetness	Severe: wetness	Moderate: wetness.
Drummond: Du	Severe: wetness; very slow permeability.	Moderate: wetness	Severe: wetness; very slow permeability.	Moderate: wetness.
*Farnum: Fa	Moderate: moderately slow permeability.	Slight	Moderate: moderately slow permeability.	Slight.
Fc, Fd, Fe, Fs. For Slickspots part of Fs, see Slickspots.	Moderate: moderately slow permeability.	Slight	Moderate: moderately slow permeability.	Slight.
Geary: Gc, Gd, Ge	Slight	Slight	Slight: moderate where slopes are more than 2 percent.	Slight.
Goessel: Go, Gs	Severe: very slow permeability and fine texture.	Severe: fine texture	Severe: very slow permeability and fine texture.	Severe: fine texture.
Hobbs: Ho	Severe: flooding	Moderate: flooding	Severe: flooding	Slight.
Irwin: Ir, Is, It	Severe: very slow permeability.	Moderate: moderately fine textured surface layer.	Severe: very slow permeability.	Moderate: moderately fine textured surface layer.
Kaski: Ka	Severe: flooding	Moderate: flooding	Severe: flooding	Slight.
*Ladysmith: La, Lb, Ld. For Slickspots part of Ld, see Slickspots.	Severe: very slow permeability.	Moderate: wetness and moderately fine textured surface layer.	Severe: very slow permeability.	Moderate: moderately fine textured surface layer.
Lesho: Le	Moderate: wetness and moderately slow permeability.	Moderate: wetness	Moderate: wetness and moderately slow permeability.	Moderate: wetness.
Naron: Na, Nb	Slight	Slight	Slight: moderate where slopes are more than 2 percent.	Slight.
Plevna. Mapped only with Dillwyn soil.	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
*Pratt: Pa, Pc, Pt. For Carwile part of Pc, see Carwile series. For Tivoli part of Pt, see Tivoli loamy fine sand.	Moderate: coarse-textured surface layer.	Moderate: coarse-textured surface layer.	Moderate: slope and coarse-textured surface layer.	Moderate: coarse-textured surface layer.
Rosehill: Ro, Rs	Severe: very slow permeability and fine-textured surface layer.	Severe: fine-textured surface layer.	Severe: very slow permeability and fine-textured surface layer.	Severe: fine-textured surface layer.

TABLE 5.—*Limitations of soils for recreational uses*—Continued

Soil series and map symbols	Campsites	Picnic areas	Intensive play areas	Trails and paths
Slickspots. No interpretations; properties variable.				
Smolan: Sm	Moderate: slow permeability; moderately fine textured surface layer.	Moderate: moderately fine texture.	Moderate: slow permeability; moderately fine texture.	Moderate: moderately fine texture.
Tivoli:				
Tv	Severe: coarse texture; slope.	Severe: coarse texture; slope.	Severe: coarse texture and slope.	Severe: coarse texture.
Tivoli part of Pt	Moderate: coarse texture and slope.	Moderate: coarse texture.	Severe: slope	Moderate: coarse texture.

Campsites are areas to be used for camping in tents and small trailers. The soils should be suitable for heavy foot traffic and vehicular traffic. These areas are used frequently during the camping season. Suitability of the soils for vegetation should be considered separately in selecting campsites.

Ratings for picnic areas are based on the features of the soil only. Other considerations, such as lakes, trees, or beauty, may affect the desirability of the site.

Intensive play areas are used for baseball, football, and badminton, as well as for unorganized play. The soils should be nearly level, well drained, and free of surface rock. It is assumed that a good vegetative cover can be established and maintained if needed.

Trails and paths are used for cross-country hiking and horseback riding. It is not anticipated that the soils will have to be graded and shaped to any great extent. Ratings are based on soil features only and do not include other items important in the selection of a site for this use.

Assistance in planning a recreation enterprise and help in determining soil suitability for various recreation uses are available from the Soil Conservation Service office in Newton, Kansas.

Engineering Uses of the Soils [7]

This section is useful to those who need information about soils used as structural material or as foundations upon which structures are built. Among those who can benefit from this section are planning commissioners, town and city managers, land developers, engineers, contractors, and farmers.

Among the soil properties important in engineering are permeability, strength, compaction characteristics, drainage, shrink-swell potential, grain-size distribution, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting the performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most information in this section is presented in tables 6 and 7, which show, respectively, estimates of soil properties significant in engineering and interpretations for various engineering uses.

This information, along with the soil map and other parts of the survey, can be used to make interpretations in addition to those given in table 7 and also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or require excavations to depths greater than those shown in the tables. Inspection of sites, especially the small ones, is also needed because many delineated areas of a given soil contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some terms used in this soil survey have different meanings in soil science than in engineering. The Glossary defines many of these terms as they are commonly used in soil science.

[7] By GENE F. BOHNENBLUST, civil engineer, Soil Conservation Service.

Engineering classification systems

The two systems most commonly used in classifying soils for engineering purposes are the Unified system (*8*) used by the Soil Conservation Service, the Department of Defense, and other agencies and the AASHO system (*1*) developed by the American Association of State Highway Officials and widely used by highway engineers.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, ML–CL. Estimated Unified classifications of all the soils in the county are given in table 6.

In the AASHO system soils are classified according to those properties that affect use in highway construction and maintenance. Soils are placed in one of seven basic groups that range from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, the best soils for road fill; at the other extreme, in group A–7, are clay soils that have low strength when wet and are the poorest soils for subgrade. If laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are subdivided as follows: A–1–a, A–1–b; A–2–4, A–2–5, A–2–6, A–2–7; and A–7–5 and A–7–6. As an additional refinement, the relative engineering values of soils within a group can be indicated by group index numbers. Group indexes range from 0 for the best material to 20 or more for the poorest. Estimated AASHO classifications for all the soils in the county are given in table 6. No laboratory data were available to justify the subdivision of the classes or the addition of group index numbers.

The USDA textural classification is based on the relative proportions of sand, silt, and clay particles that make up the soil (*5*).

Estimated engineering properties of the soils

Table 6 shows estimates of properties of the soils of Harvey County that affect the use of the soils in engineering. The estimates are based on tests of similar soils in other counties, on field observations, and on information in other parts of this survey.

The thickness of the soil layers shown in table 6 differs in some instances from those shown in the description of the representative profile in the section "Descriptions of the Soils," because layers that have similar engineering properties were combined and listed as one layer.

The USDA textural classification and the engineering classifications are explained under the heading "Engineering classification systems."

In the columns that give percentages passing sieves of various sizes, the percentage of material smaller in diameter than the sieve opening of the given screens is listed.

Permeability is the capacity of the soil to transmit water or air. It is measured in terms of the rate at which water passes through a saturated soil profile. The column that shows permeability gives, in inches per hour, the estimated rate at which water percolates through undisturbed and uncompacted soil. The estimates are based on observations of the porosity and structure of the soil.

Available water capacity is the amount of capillary water that remains in the soil and is available to plants after all free water has drained away. It is expressed in inches of water per inch of soil.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with a change in moisture content. In general, a high shrink-swell potential presents hazards to maintenance of engineering structures built in, on, or with such materials.

Most soils in the county are deep enough that bedrock does not affect their use for engineering purposes. Shale is at a depth of 20 to 40 inches in Clime and Rosehill soils. The material between the described profile and bedrock in the deeper soils consists of thick deposits of old alluvium, outwash, and windblown material.

Only a few soils in the county have a water table high enough to pose a problem in engineering. Dillwyn soils have a water table that fluctuates between depths of about 1 and 5 feet. The water table of Plevna soils fluctuates from near the surface to a depth of about 4 feet. Lesho soils have a water table between depths of about 2 and 5 feet, and in some areas Drummond soils have a water table between depths of 5 and 10 feet. Carwile soils have a perched water table during some wet seasons. The water table in Hobbs and Kaski soils is at a depth below 5 feet except during floods or heavy streamflow.

Dispersion, or the degree to which particles smaller than 0.005 millimeter separate or disperse in the presence of water, is a problem only with Drummond soils and the Slickspots part of Farnum-Slickspots complex and Ladysmith-Slickspots complex. Dispersed soils are unstable and hazardous for any engineering purpose.

Interpretations of engineering properties

Table 7 shows the suitability of soil material for certain uses and describes specific characteristics of each soil series that affect the design and application of construction measures. Some hazards related to construction and maintenance are given in the table.

Ratings are given for the suitability of soil material as topsoil, sand, and gravel. Soils are rated poor or fair as a source of topsoil if they are eroded, are low in content of organic matter or natural fertility, or have a clayey surface layer that is difficult to handle or to work. Soils rated as poor or fair sources of sand or gravel may require extensive exploration to find material that will meet requirements.

The ratings for road subgrade, road fill, or highway location were made by representatives of the Kansas State Highway Commission. The ratings are based on a thorough knowledge of the material and its properties as they affect highway construction.

The features shown for a given soil were based on the normal profile of that soil, as shown in table 6. Variations in the profile could change the ratings of the soils for use in some construction and engineering practices.

TABLE 6.—*Estimated engineering*

[An asterisk before the series name in the first column indicates that at least one mapping unit in the series is made up of two or more
The sign <

Soil series and map symbols	Depth from surface (typical profile)	Classification		
		USDA texture	Unified	AASHO
	In.			
Alluvial land, broken: Ad. No valid estimates. Variable material.				
Breaks-Alluvial land: Ba. No valid estimates. Variable material.				
Carwile: Ca	0–18	Fine sandy loam	SM or ML	A–4
	18–28	Clay	CH	A–7
	28–60	Clay loam	CL	A–6
Clark: Cc	0–60	Clay loam	CL	A–6
Clime: Cd, Ce, Cf, Cm	0–30	Silty clay	CH or CL	A–7
	30–40	Clay shale.		
Crete: Cr, Ct	0–11	Silt loam	CL	A–6
	11–17	Silty clay loam	CL	A–7
	17–46	Silty clay	CH	A–7
	46–60	Silty clay loam	CL	A–7
Detroit: De	0–17	Silty clay loam	CL	A–7
	17–36	Silty clay	CH	A–7
	36–60	Silty clay loam	CL	A–7
*Dillwyn: Dp, Dt For Plevna part of Dp, see Plevna series. For Tivoli part of Dt, see Tivoli fine sand.	0–60	Loamy fine sand	SM	A–2
Drummond: Du	0–9	Loam	ML or CL	A–4
	9–21	Silty clay	CH or CL	A–7
	21–60	Silty clay loam	CL	A–7
*Farnum:				
Fa	0–13	Fine sandy loam	SM	A–4
	13–32	Clay loam	CL	A–7
	32–47	Sandy clay loam	SC or CL	A–6
	47–60	Fine sandy loam	SM	A–4
Fc, Fd, Fe, Fs For Slickspots part of Fs, see Slickspots.	0–14	Loam	ML or ML-CL	A–4 or A–6
	14–35	Clay loam	CL	A–7
	35–45	Sandy clay loam	SC	A–6
	45–60	Sandy loam	SM	A–2 or A–4
Geary: Gc, Gd, Ge	0–9	Silt loam	ML or CL	A–4
	9–26	Silty clay loam	CL	A–7
	26–60	Clay loam	CL	A–7
Goessel: Go, Gs	0–60	Silty clay	CH	A–7
Hobbs: Ho	0–60	Silt loam	ML or CL	A–4 or A–6
Irwin: Ir, Is, It	0–11	Silty clay loam	CL	A–7
	11–60	Silty clay	CH	A–7
Kaski: Ka	0–24	Loam	CL or ML	A–6
	24–60	Clay loam	CL	A–6
*Ladysmith: La, Lb, Ld For Slickspots part of Ld, see Slickspots.	0–10	Silty clay loam	CL	A–7 or A–6
	10–45	Silty clay	CH	A–7
	45–60	Silty clay loam	CL	A–7
Lesho: Le	0–17	Loam	CL or ML	A–4
	17–30	Clay loam	CL	A–6
	30–54	Loamy sand	SM	A–2
	54–60	Fine sand	SM	A–2

properties of the soils

kinds of soil. Since the different soils may have different properties, it is important to follow the instructions for referring to other series.
means less than]

Percentage less than 3 inches in diameter passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
			In. per hr.	*In. per in. of soil*	*pH*	
100	70–85	45–55	2. 00–4. 00	0. 09–0. 13	5. 6–6. 5	Low.
100	90–100	75–95	0. 06–0. 20	0. 14–0. 18	6. 1–7. 8	High.
100	90–100	70–80	0. 20–0. 63	0. 15–0. 19	6. 6–7. 8	Moderate.
100	90–100	70–80	0. 63–2. 00	0. 15–0. 19	7. 4–8. 4	Moderate.
100	95–100	90–95	0. 20–0. 63	0. 14–0. 18	7. 4–8. 4	Moderate.
100	90–100	90–100	0. 63–2. 00	0. 14–0. 18	5. 6–6. 5	Low.
100	95–100	90–100	0. 20–0. 63	0. 15–0. 19	5. 6–6. 5	Moderate.
100	95–100	90–100	0. 06–0. 20	0. 14–0. 18	6. 1–7. 8	High.
100	95–100	90–100	0. 20–0. 63	0. 15–0. 19	6. 6–7. 8	Moderate.
100	95–100	85–95	0. 20–0. 63	0. 15–0. 19	6. 1–7. 3	Moderate.
100	95–100	90–95	0. 06–0. 20	0. 14–0. 18	6. 1–7. 3	High.
100	95–100	85–95	0. 20–0. 63	0. 15–0. 19	6. 6–7. 8	Moderate.
100	90–95	15–25	6. 30–10. 0	0. 06–0. 09	5. 6–7. 3	Low.
100	85-95	60–75	0. 20–0. 63	0. 12-0. 16	6. 1-7. 8	Low.
100	95-100	90-95	<0. 06	0. 14-0. 18	6. 6-8. 4	Moderate.
100	95-100	85-95	0. 06–0. 20	0. 15–0. 19	7. 4–8. 4	Moderate.
100	70–85	40–50	1. 00–2. 00	0. 09–0. 13	5. 6–7. 3	Low.
100	90–100	70–80	0. 20–0. 63	0. 15–0. 19	6. 1–7. 8	Moderate.
100	80-90	35-55	0. 63-2. 00	0. 12-0. 16	6. 1-7. 8	Low.
100	70-85	40-50	1. 00-2. 00	0. 09-0. 13	6. 6-8. 4	Low.
100	85-95	60-75	0. 63-1. 20	0. 12-0. 16	5. 6-7. 3	Low.
100	90–100	70–80	0. 20–0. 63	0. 15–0. 19	5. 6–7. 8	Moderate.
100	80-90	36-50	0. 63-2. 00	0. 12-0. 16	6. 1-7. 8	Low.
100	60-70	30-40	1. 0	0. 09-0. 13	6. 6-8. 4	Low.
100	90–100	70–90	0. 63–2. 00	0. 14–0. 18	5. 6–6. 5	Low.
100	95–100	85–95	0. 63–2. 00	0. 15–0. 19	5. 6–7. 3	Moderate.
100	90–100	70-80	0. 63-2. 00	0. 15-0. 19	6. 1-7. 3	Moderate.
100	95-100	90-100	<0. 06	0. 14-0. 18	6. 1-8. 4	High.
100	90-100	80-95	0. 63-2. 00	0. 14-0. 18	6. 1-7. 8	Low.
100	90-100	90-100	0. 20-0. 63	0. 15-0. 19	5. 6-6. 5	Moderate.
100	90-100	90-100	<0. 06	0. 14-0. 18	5. 6-7. 8	High.
100	85-95	60-75	0. 63-2. 00	0. 12-0. 16	5. 6-6. 5	Low.
100	90–100	70–80	0. 63–2. 00	0. 15–0. 19	5. 6–7. 3	Moderate.
100	95–100	85–100	0. 20–0. 63	0. 15–0. 19	5. 6–6. 5	Moderate.
100	95–100	90–100	<0. 06	0. 14–0. 18	5. 6–7. 3	High.
100	95–100	85–100	0. 20–0. 63	0. 15–0. 19	6. 6–7. 8	Moderate.
100	85–95	60–75	0. 63–2. 00	0. 12–0. 16	7. 4–8. 4	Low.
100	90–100	70–80	0. 20–0. 63	0. 15–0. 19	7. 4–8. 4	Moderate.
100	50–75	15–30	4. 00–6. 30	0. 06–0. 09	7. 4–8. 4	Low.
100	65–80	20–35	4. 00–6. 30	0. 06–0. 09	7. 4–8. 4	Low.

TABLE 6.—*Estimated engineering*

Soil series and map symbols	Depth from surface (typical profile)	Classification		
		USDA texture	Unified	AASHO
	In.			
Naron: Na, Nb	0–16	Fine sandy loam	SM or SC	A–4
	16–31	Sandy clay loam	SC	A–6
	31–60	Fine sandy loam	SM or SC	A–4
Plevna	0–42	Fine sandy loam	SM	A–4
	42–60	Fine sand	SM	A–2
Mapped only with Dillwyn soil.				
*Pratt: Pa, Pc, Pt	0–60	Loamy fine sand	SM	A–2
For Carwile part of Pc, see Carwile series. For Tivoli part of Pt, see Tivoli loamy fine sand.				
Rosehill: Ro, Rs	0–34	Silty clay	CH	A–7
	34–50	Clay shale.		
Slickspots. No estimates. Properties too variable.				
Smolan: Sm	0–16	Silty clay loam	CL	A–7
	16–50	Silty clay	CH	A–7
	50–60	Silty clay loam	CL	A–7
Tivoli:				
Tv	0–60	Fine sand	SP–SM	A–3
Tivoli part of Pt	0–16	Loamy fine sand	SM	A–2
	16–60	Fine sand	SP–SM	A–3

TABLE 7.—*Interpretations of*

[An asterisk before the series name in the first column indicates that at least one mapping unit in the series is made up of two or more for referring to

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Highway location [1]	Dikes and levees [2]	Farm ponds: Reservoir area
Alluvial land, broken: Ad. No estimates; properties too variable.							
Breaks-alluvial land complex: Ba. No estimates; properties too variable.							
Carwile: Ca	Fair	Unsuitable	Good in surface layer. Poor in subsoil: high plasticity.	Fair: fair shear strength.	Somewhat poorly drained; temporary perched water table.	Erodible slopes; fair stability; fair compaction characteristics.	Slow permeability.

properties of the soils—Continued

Percentage less than 3 inches in diameter passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
			In. per hr.	*In. per in. of soil*	*pH*	
100	70–85	40–50	0. 63–2. 00	0. 09–0. 13	5. 6–6. 5	Low.
100	80–90	36–50	0. 63–2. 00	0. 12–0. 16	5. 6–7. 3	Low.
100	70–85	40–50	0. 63–2. 00	0. 09–0. 13	6. 1–7. 8	Low.
100	90–100	30–50	2. 00–6. 30	0. 09–0. 13	5. 6–6. 5	Low.
100	65–80	20–35	6. 30–10. 0	0. 06–0. 09	5. 6–6. 5	Low.
100	85–100	15–25	6. 30–10. 0	0. 06–0. 09	5. 6–7. 3	Low.
100	95–100	90–95	<0. 06	0. 14–0. 18	6. 1–8. 4	High.
100	95–100	85–95	0. 20–0. 63	0. 15–0. 19	5. 6–6. 5	Moderate.
100	95–100	90–95	0. 06–0. 20	0. 14–0. 18	5. 6–7. 3	High.
100	95–100	85–95	0. 20–0. 63	0. 15–0. 19	6. 6–7. 8	Moderate.
100	80–100	5–10	6. 30–10. 0	0. 06–0. 09	6. 1–7. 8	Low.
100	80–100	15–25	6. 30–10. 0	0. 06–0. 09	6. 1–7. 3	Low.
100	80–100	5–10	6. 30–10. 0	0. 06–0. 09	6. 1–7. 8	Low.

engineering properties

kinds of soil. Since the different soils may have different properties and degrees of limitation, it is important to follow the instructions other series]

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds—Continued	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Embankment							
Temporary perched water table; fair stability; fair compaction characteristics; erodible slopes.	Temporary perched water table; slow permeability; nearly level.	Poor surface drainage; slow permeability.	Nearly level; limited surface runoff.	Nearly level; limited surface runoff.	High shrink-swell potential in subsoil; temporary perched water table.	Severe: temporary perched water table; slow permeability.	Moderate to severe: temporary perched water table.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Highway location [1]	Dikes and levees [2]	Farm ponds: Reservoir area
Clark: Cc	Fair in surface layer. Poor in subsoil.	Unsuitable	Fair: medium plasticity.	Good	Well drained; highly calcareous; erodible; difficult to establish vegetation on subsoil.	Calcareous; slopes difficult to vegetate.	Moderate permeability.
Cline: Cd, Ce, Cf, Cm	Fair	Unsuitable	Fair: medium plasticity.	Good	Gently sloping to sloping; shale at depth of 20 to 40 inches.	Generally not applicable.	Moderately slow permeability; shale at depth of 20 to 40 inches.
Crete: Cr, Ct	Good in surface layer.	Unsuitable	Poor: high plasticity; poor shear strength.	Fair: poor shear strength.	Moderately well drained; slow permeability.	High shrink-swell potential.	Slow permeability.
Detroit: De	Good in surface layer.	Unsuitable	Fair: medium plasticity.	Good	Nearly level; occasional flooding.	Moderate to high shrink-swell potential.	Slow permeability.
*Dillwyn: Dp, Dt. For Plevna part of Dp, see Plevna series. For Tivoli part of Dt, see Tivoli series.	Poor	Poor	Good	Good	Erodible; water table at depth of 1 to 5 feet.	Erodible on slopes; subject to piping; pervious substratum.	Water table at depth of 1 to 5 feet.
Drummond: Du	Unsuitable	Unsuitable	Poor: moderate shrink-swell potential.	Poor: poor stability.	Nearly level; somewhat poorly drained; poor stability.	Steep slopes unstable.	Very slow permeability.
*Farnum: Fa	Good	Unsuitable	Fair: medium plasticity.	Good	Features generally favorable.	Fair stability; unstable if dispersed.	Moderately slow permeability.
Fc, Fd, Fe, Fs. For Slickspots part of Fs, see Slickspots.	Good	Unsuitable	Fair: medium plasticity.	Good	Features generally favorable.	Fair stability	Moderately slow permeability.
Geary: Gc, Gd, Ge	Good	Unsuitable	Fair: medium plasticity.	Good	Features generally favorable.	Fair stability and compaction characteristics.	Moderate permeability.

engineering properties—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds—Continued	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Embankment							
Calcareous; low to moderate shear strength; slopes difficult to vegetate.	Moderate permeability.	Moderate permeability; high available water capacity.	Calcareous; subsoil low in fertility.	Calcareous; difficult to establish vegetation on subsoil.	Moderate shrink-swell potential.	Moderate: moderate permeability.	Moderate: moderate permeability.
Limited borrow; shale at depth of 20 to 40 inches.	Not applicable.	Generally not applicable.	Thin surface layer.	Difficult to establish vegetation on subsoil.	Moderate shrink-swell potential; shale at depth of 20 to 40 inches.	Severe: moderately slow permeability.	Severe: shale at depth of 20 to 40 inches.
Poor shear strength; high shrink-swell potential.	Slow permeability; moderately well drained.	Deep; slow permeability; high available water capacity.	Moderately erodible.	Moderately erodible.	High shrink-swell potential.	Severe: slow permeability.	Slight to moderate: nearly level to gently sloping.
Low shear strength; moderate to high shrink-swell potential.	Slow permeability.	Deep; slow permeability; high available water capacity.	Nearly level	Nearly level; occasional flooding.	Moderate to high shrink-swell potential; occasional flooding	Severe: slow permeability; subject to flooding.	Severe: occasional flooding.
Erodible on slopes; water table at depth of 1 to 5 feet.	Poor surface drainage; water table at depth of 1 to 5 feet.	Poor surface drainage; water table at depth of 1 to 5 feet.	Nearly level	Nearly level	Poor surface drainage; water table at depth of 1 to 5 feet.	Severe: water table at depth of 1 to 5 feet.	Severe: water table at depth of 1 1 to 5 feet.
Low shear strength; steep slopes unstable.	Very slow permeability.	Generally not applicable.	Not applicable.	Not applicable.	Moderate shrink-swell potential; somewhat poorly drained.	Severe: very slow permeability.	Slight.
Fair stability; unstable if dispersed.	Well drained	Moderately slow permeability.	Nearly level	Nearly level	Moderate shrink-swell potential.	Severe: moderately slow permeability.	Slight.
Fair stability	Well drained	Moderately slow permeability in subsoil.	Nearly level to moderately sloping.	Nearly level to moderately sloping.	Moderate shrink-swell potential.	Severe: moderately slow permeability.	Slight to moderate: nearly level to moderately sloping.
Fair stability and compaction characteristics.	Well drained	Deep; moderate permeability.	Deep, stable material.	Features generally favorable.	Moderate shrink-swell potential.	Slight to moderate: moderate permeability.	Moderate: moderate permeability; nearly level to moderately sloping.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Highway location [1]	Dikes and levees [2]	Farm ponds: Reservoir area
Goessel: Go, Gs	Poor	Unsuitable	Poor: high plasticity; poor shear strength.	Fair: poor shear strength.	Nearly level to gently sloping; moderately well drained; very slow permeability.	Poor shear strength; cracks when dry.	Very slow permeability.
Hobbs: Ho	Good	Unsuitable	Poor: poor stability.	Good	Nearly level; subject to flooding.	Pervious substratum in places.	Previous substratum in places.
Irwin: Ir, Is, It	Fair in surface layer. Poor in subsoil.	Unsuitable	Poor: high plasticity; poor shear strength.	Fair: poor shear strength.	Well drained; very slow permeability.	Fair to poor stability; highly plastic.	Very slow permeability.
Kaski: Ka	Good	Poor: local pockets.	Poor: poor stability.	Good	Nearly level; subject to flooding.	Fair to good compaction characteristics; pervious substratum in places.	Pervious substratum in places.
*Ladysmith: La, Lb, Ld. For Slickspots part of Ld, see Slickspots.	Fair in surface layer. Poor in subsoil.	Unsuitable	Poor: high plasticity; poor shear strength.	Fair: poor shear strength.	Nearly level to gently sloping; moderately well drained; very slow permeability.	Poor to fair stability; cracks when dry.	Very slow permeability.
Lesho: Le	Good in surface layer.	Poor: local pockets.	Poor: poor stability; substratum good if confined.	Good	Water table at depth of 2 to 5 feet; slight hazard of flooding.	Moderately erodible slopes; pervious substratum.	Pervious substratum; good for pits dug to water table.
Naron: Na, Nb	Good	Unsuitable	Good	Good	Erodible	Fair stability; and compaction characteristics; erodible slopes.	Moderate permeability.
Plevna Mapped only with Dillwyn soils.	Poor	Unsuitable	Good	Good	Erodible; water table at depth of 0 to 4 feet.	Erodible slopes; subject to piping.	Fine sand substratum; water table at depth of 0 to 4 feet.

engineering properties—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds—Continued	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Embankment							
Poor shear strength; highly plastic; cracks when dry.	Slow surface drainage; very slow permeability.	Very slow permeability.	Nearly level to gently sloping.	Nearly level to gently sloping; highly plastic.	High shrink-swell potential.	Severe: very slow permeability.	Slight.
Fair compaction characteristics.	Well drained; subject to flooding.	Subject to flooding.	Subject to flooding.	Nearly level; subject to flooding.	Subject to flooding.	Severe: subject to flooding.	Moderate to severe: subject to flooding.
Fair to poor stability and compaction characteristics; highly plastic.	Well drained	Deep; very slow permeability.	Moderately erodible; sloping; highly plastic.	Moderately erodible; sloping; highly plastic.	High shrink-swell potential.	Severe: very slow permeability.	Slight to moderate: gently sloping to moderately sloping.
Fair to good compaction characteristics.	Well drained; subject to flooding.	Subject to flooding.	Subject to flooding.	Nearly level; subject to flooding.	Subject to flooding.	Severe: subject to flooding.	Moderate to severe: subject to flooding.
Fair to poor stability; high shrink-swell potential.	Poor surface drainage; very slow permeability.	Poor surface drainage; very slow permeability.	Nearly level to gently sloping.	Nearly level to gently sloping; highly plastic.	High shrink-swell potential.	Severe: very slow permeability.	Slight.
Substratum material needs binder; water table at depth of 2 to 5 feet.	Water table at depth of 2 to 5 feet.	Somewhat poorly drained; water table at depth of 2 to 5 feet.	Nearly level	Nearly level	Water table at depth of 2 to 5 feet.	Severe: water table at depth of 2 to 5 feet.	Severe: pervious substratum; water table at depth of 2 to 5 feet.
Fair stability and compaction characteristics.	Well drained	High intake rate.	Subject to blowing; nearly level to gently sloping.	Erodible by wind and water; nearly level to gently sloping.	Features generally favorable.	Slight	Moderate: moderate permeability.
Erodible slopes; subject to piping; water table at depth of 0 to 4 feet.	Poor surface drainage; water table at depth of 0 to 4 feet.	Water table at depth of 0 to 4 feet.	Not applicable	Not applicable	Water table at depth of 0 to 4 feet.	Severe: water table at depth of 0 to 4 feet.	Severe: water table at depth of 0 to 4 feet.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Highway location [1]	Dikes and levees [2]	Farm ponds
							Reservoir area
*Pratt: Pa, Pc, Pt. For Carwile part of Pc, see Carwile series. For Tivoli part of Pt, see Tivoli series.	Poor	Fair for road sand; unsuitable for gravel.	Good	Good	Erodible	Erodible slopes; pervious.	Rapid permeability.
Rosehill: Ro, Rs	Poor	Unsuitable.	Poor: high plasticity; poor shear strength.	Fair: poor shear strength.	Gently sloping to moderately sloping; shale at depth of 22 to 40 inches.	Not applicable.	Very slow permeability.
Smolan: Sm	Fair	Unsuitable.	Poor: high plasticity; poor shear strength.	Fair: poor shear strength.	Well drained; slow permeability.	Poor to fair stability.	Slow permeability.
Slickspots. No estimates; properties too variable.							
Tivoli: Tv	Poor	Fair for road sand; unsuitable for gravel.	Good if confined.	Good if confined.	Highly erodible.	Erodible slopes; pervious.	Excessive seepage.

[1] Norman Clark, soils engineer, and Herbert E. Worley, soils research engineer, Kansas State Highway Commission, assisted in preparing these columns.

engineering properties—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds—Continued	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Embankment							
High seepage rate; erodible; needs binder.	Well drained	Rapid intake rate; low available water capacity.	Subject to blowing; little or no runoff.	Low fertility	Features generally favorable.	Slight: severe where pollution is a hazard.	Severe: rapid permeability.
Low stability; cracks when dry.	Well drained	Generally not applicable.	Moderately erodible; highly plastic.	Subsoil poor for vegetation.	High shrink-swell potential.	Severe: very slow permeability.	Severe: shale at depth of 22 to 40 inches.
Poor to fair stability and compaction characteristics.	Well drained	Deep; gently sloping; high available water capacity.	Moderately erodible; subsoil plastic.	Moderately erodible; fair fertility.	High shrink-swell potential.	Severe: slow permeability.	Moderate: sloping.
Excessive seepage; highly erodible slopes.	Not applicable.	Sand hill topography; rapid permeability; low available water capacity.	Not applicable.	Droughty; low fertility; erodible.	Steep, irregular slopes.	Slight: severe where pollution is a hazard.	Severe: rapid permeability.

[2] Embankments more than 25 feet high are not considered.

Formation and Classification of the Soils

This section consists of two main parts. The first part tells how the factors of soil formation have affected the development of soils in Harvey County. The second part explains the system of soil classification and places each soil series represented in Harvey County in the classes of that system.

Factors of Soil Formation

The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly bring about the development of genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Typically, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many processes of soil formation are unknown.

Parent material

Parent material, the unconsolidated material from which a soil forms, is a result of the weathering of rocks through the processes of freezing and thawing, soil blowing and erosion, and the grinding away of rocks by rivers and glaciers. It forms as a result of chemical processes.

The oldest geologic formation furnishing parent material in Harvey County is the Wellington Formation of the Permian System (*9*), which crops out in the eastern part of the county. It is soft, calcareous, gray and bluish-gray shale that contains several thin beds of limestone and gypsum. Soils believed to have formed in material weathered from this shale are the Rosehill and Clime soils.

During the Pleistocene epoch streams deposited sediments that ranged from sand to clay. Some of these outwash sediments were reworked by wind before vegetation became established. Other areas were covered by varying thicknesses of windblown materials. Farnum, Carwile, Geary, Irwin, and Crete soils formed in these materials.

Eolian sand is the parent material of some of the soils in the county. The sand is believed to have been derived from deposits in the Arkansas Valley and from older Pleistocene stream deposits southwest of this area (*9*). Soils in Harvey County that formed from these sands are the Pratt, Dillwyn, and Tivoli soils. Naron, Farnum, and Carwile soils appear to have formed partly from eolian deposits.

Alluvium of late Quaternary age is in stream valleys (*9*). Soils that formed in these sediments are the Lesho, Hobbs, Detroit, and Kaski soils.

Climate

Climate has played an important role in the development of soils in Harvey County. Precipitation, temperature, and wind each have an effect on the type of soil profile that develops from parent material.

Moisture from rainfall and other sources enters the soil, dissolves soluble materials, and transports them downward. It permits plants to grow and to contribute organic matter to the soil. As moisture moves downward, it carries clay particles and minerals with it and deposits them in the subsoil, or B horizon. Moisture also allows soil organisms to increase in number and activity. These organisms help to darken the soil by changing plant material to soil organic matter.

Variations in temperature affect soils in several ways. Alternate freezing and thawing break up soil aggregates and change soil structure. As temperature increases, more evaporation takes place and less moisture is available for plant growth. The growth of organisms generally increases as temperature increases. Another factor that increases with a rise in temperature is the rate at which chemicals react and affect the weathering of minerals and decomposition of organic material.

Wind also has its effect on soil formation. Most of the precipitation in Harvey County falls in summer. The hot summer wind, however, evaporates moisture rapidly. It blows the fine particles from the surface layer, thus decreasing soil fertility. Wind also blows particles of soil material from one area to another and thus changes the texture of the surface layer.

Plant and animal life

Animal life and vegetation are indispensable in soil development. Burrowing animals, insects, and worms help to mix the soil. Bacteria, fungi, and other microorganisms help to weather rock and decompose organic material. Plant and animal life also influence the chemical and biological processes that take place in the soil.

Plants are the main source of organic matter, which causes the dark color of soils. The soils of Harvey County formed under tall and mid grasses, which supply soil with enormous amounts of roots that decay and add organic matter. Organic matter from decayed roots accounts for the dark-colored surface layer of the soils of Harvey County.

Relief

Relief, or lay of the land, influences formation of soils through its effect on drainage, erosion, temperature, and plant cover. Runoff becomes excessive where slopes are moderate and steep, because the soil is unable to absorb all the moisture from rainfall. If the soil is not protected

by a cover of plants, excessive runoff causes a steep soil to erode more readily than a less sloping one.

Soils in low-lying areas where surface drainage is poor are likely to have a dark-gray or mottled subsoil. An example in Harvey County is the Carwile soils.

Time

Time is needed for soils to form from parent material. Some soils form rapidly, and others form slowly. The length of time required for a particular soil to form depends on the other factors involved. As water moves downward through the soil, soluble material and fine particles are leached from the surface layer and deposited in the subsoil. How long this process takes depends chiefly on how long the soil material has been in place and how much water penetrates it.

Some soils lack horizon development because they formed in material that is highly resistant to weathering. Tivoli soils are an example. Other soils, such as Hobbs or Lesho, show little horizon development because they are young and time has been insufficient for genetic horizons to develop in them. Crete soils have been exposed to soil-forming processes for thousands of years and have well-defined horizons.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, see their relationship to one another and to the whole environment, and develop principles that help us understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Soils are classified into narrow categories used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broader categories to facilitate comparison between large areas, such as countries and continents.

The soil classification system currently used in the United States was adopted for general use by the National Cooperative Soil Survey in 1965 (*6*). The system is under continual study. Readers interested in the development of the system should search the available literature (*4*). In table 8, the soil series of Harvey County are placed in the broader categories of the current system.

The current system of classification has six categories. Beginning with the broadest, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are chosen so that soils of similar genesis, or

TABLE 8.—*Soil series classified according to higher categories*

Soil series	Family	Subgroup	Order
Carwile	Fine, mixed, thermic	Typic Argiaquolls	Mollisols.
Clark [1]	Fine-loamy, mixed, thermic	Typic Calciustolls	Mollisols.
Clime [2]	Fine, mixed, mesic	Udic Haplustolls	Mollisols.
Crete [3]	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Detroit	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Dillwyn	Mixed, thermic	Aquic Ustipsamments	Entisols.
Drummond	Fine, mixed, thermic	Mollic Natrustalfs	Alfisols.
Farnum [1]	Fine-loamy, mixed, thermic	Pachic Argiustolls	Mollisols.
Geary [4]	Fine-silty, mixed, mesic	Udic Argiustolls	Mollisols.
Goessel	Fine, montmorillonitic, mesic	Udic Pellusterts	Vertisols.
Hobbs	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Irwin [5]	Fine, mixed, mesic	Pachic Argiustolls	Mollisols.
Kaski [1]	Fine-loamy mixed, thermic	Cumulic Haplustolls	Mollisols.
Ladysmith [4]	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Lesho	Fine-loamy over sandy or sandy-skeletal, mixed, thermic.	Fluvaquentic Haplustolls	Mollisols.
Naron [1]	Fine-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Plevna [6]	Coarse-loamy, mixed, thermic	Fluvaquentic Haplaquolls	Mollisols.
Pratt	Sandy, mixed, thermic	Psammentic Haplustalfs	Alfisols.
Rosehill	Fine, montmorillonitic, mesic	Udertic Haplustolls	Mollisols.
Smolan	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Tivoli	Mixed, thermic	Typic Ustipsamments	Entisols.

[1] Mapping units of the Clark, Farnum, Kaski, and Naron series north and east of the Little Arkansas River are considered taxadjuncts to their respective series because they have a mean annual temperature slightly cooler than is defined as the range of the series.

[2] Mapping units of Clime soils named as an eroded phase are taxadjuncts to the Clime series because they lack mollic epipedons.

[3] Mapping units more than 40 inches deep over free carbonates are considered taxadjuncts to the Crete series. Mapping units south and west of the Little Arkansas River are considered taxadjuncts to the Crete series because they have a mean annual temperature slightly warmer than is defined as the range of the series.

[4] Mapping units of the Geary and Ladysmith series south and west of the Little Arkansas River are considered taxadjuncts to their respective series because they have a mean annual temperature slightly warmer than is defined as the range of the series.

[5] Mapping units of Irwin soils named as an eroded phase are taxadjuncts to the Irwin series because they contain mollic epipedons less than 20 inches thick.

[6] The Plevna soils in the county are taxadjuncts to the Plevna series, because they are more acid than is defined as the range of the series.

mode of origin, are grouped together. The categories of the current system are defined briefly in the following paragraphs.

ORDER.—Ten soil orders are recognized in the classification system: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. Two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. Table 8 shows that the four soil orders represented in Harvey County are Mollisols, Alfisols, Entisols, and Vertisols.

Mollisols have a thick, dark-colored surface layer that contains colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling. Soils of this order are the most extensive in area and include the majority of the soil series in Harvey County.

Alfisols are mineral soils that contain horizons of clay accumulation. Unlike the Mollisols, they lack the thick, dark-colored surface layer that contains colloids dominated by bivalent cations. However, the base saturation of the lower horizons is moderate to high.

Entisols are light-colored soils that do not have natural genetic horizons, or have only very weakly expressed beginnings of such horizons. These soils do not have traits that reflect soil mixing caused by shrinking and swelling.

Vertisols are soils that have enough swelling clay to cause cracking, shearing, and mixing of the soil material in areas where, because of climate and topography, there is alternate wetting and drying of the soil mass.

SUBORDER.—Each order is divided into suborders, primarily on the basis of those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or differences in climate or vegetation.

GREAT GROUP.—Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of major horizons and features. The horizons used to make separations are those in which clay, iron, or humus has accumulated or those that contain a hardpan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 8, because the last word in the name of the subgroup is the name of the great group.

SUBGROUP.—Each group is divided into subgroups, one that represents the central (typic) segment of the group and others, called intergrades, that have properties of one group and also one or more properties of another great group, suborder, or order. Subgroups may also be set up in those instances where soil properties intergrade outside the range of any great group, suborder, or order.

FAMILY.—Families are established within each subgroup primarily on the basis of properties important to growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. Harvey County is near the borderline between series classified as having mesic temperature regimes and series having thermic temperature regimes. In Harvey County soils classified in mesic families but mapped south and west of the Little Arkansas River are considered taxadjuncts to their respective series. Likewise, soils classified in thermic families but mapped north and east of the river are considered taxadjuncts to their respective series.

SERIES.—The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and arrangement in the profile.

General Facts About the County

This section was written mainly for those unfamiliar with Harvey County. It describes the physiography, drainage, and water supply; the climate; and the farming in the county.

Physiography, Drainage, and Water Supply

Harvey County lies within the Central Loess Plains resource area of the Central Great Plains Winter Wheat and Range resource region. In general, the landscape is a nearly level to gently rolling or sloping plain, but slopes are somewhat steeper along the major drainageways and around the sandhills in the area north of Burrton.

The highest elevation in Harvey County, about 1,550 feet, is on the county line north of Walton. The lowest, about 1,335 feet, is a mile north of the southeast corner of the county. Other approximate elevations are 1,395 feet at Halstead, 1,375 feet at Sedgwick, 1,450 feet at Burrton, and 1,450 feet at Newton.

Most of the county is drained by the Little Arkansas River. It enters Harvey County about 5½ miles south of the northwest corner and flows into Sedgwick County near the city of Sedgwick. Its tributaries are Kisiwa Creek, Blaze Fork Creek, Turkey Creek, Black Kettle Creek, Emma Creek, Sand Creek, Jester Creek, and Gooseberry Creek. Black Kettle Creek flows nearly parallel to the Little Arkansas River for almost 5 miles before entering the river at Halstead. Sand Creek flows through Newton and enters the Little Arkansas River at Sedgwick. Kisiwa Creek enters Harvey County near Burrton and enters the Little Arkansas River about midway between Halstead and Sedgwick. Jester Creek and Gooseberry Creek flow into Sedgwick County before entering the river.

The northeastern part of the county is drained by Doyle Creek, and the southeastern part is drained by Wildcat Creek and Gypsum Creek.

West Whitewater Creek and East Whitewater Creek are east of Walton. They join near Whitewater to form the West Whitewater River, which flows into Butler County.

An area from Burrton north to the Little Arkansas River does not have an established drainage pattern. Al-

though some soils are steep, they are sandy and absorb the precipitation that falls.

Most of the area south of Kisiwa Creek lacks a well-defined drainage pattern. The soils are nearly level. Several intermittent lakes are scattered throughout this area.

The eastern part of the county has very little ground water, and what is there is of poor quality. Some livestock water is supplied by ponds.

The western part of the county has a large supply of good-quality water in the Equus beds of the Meade Formation. In an area around Burrton, however, the water is of poor quality. A major part of the water used by Wichita comes from wells in the southwestern part of Harvey County.

The greater part of the irrigation water supply comes from the Equus beds. A few irrigators take water from Sand Creek and the Little Arkansas River. Irrigation systems are gravity and sprinkler types.

Climate [8]

Harvey County, in south-central Kansas, has a continental climate characterized by large day-to-day and annual ranges of temperature, low to moderate humidity, a high percentage of days with sunshine, moderate and irregular precipitation, and a maximum of rainfall during the warm season. The county is located in the zone of prevailing westerlies, where changeable weather is the rule. Fronts and low-pressure storm centers, which frequently traverse the area, produce a variety of weather.

Much precipitation in Kansas is caused by the collision of warm, moist air from the Gulf of Mexico with cold, dry air from northern latitudes. A higher frequency of the flow of Gulf air over the eastern part of Kansas than over the western part results in a pronounced variation in rainfall across the State (*3*). Annual precipitation in Harvey County, which averages 30½ inches, is intermediate between the light rainfall in semiarid southwestern Kansas and the heavy precipitation in the extreme southeastern part of the State. The bulk of the precipitation falls during the growing season of April through October. This distribution is of great significance to farming. The normal rainfall of 24.27 inches during this 7-month period is nearly 80 percent of the annual amount. Winters are very dry; only 10 percent of the annual precipitation falls during the winter season of December through February. January, which has 0.91 inch, is the only month with a normal precipitation of less than 1 inch. Monthly rainfall gradually increases as spring and summer approach, reaching a maximum in May and June. On the average, there are 85 to 90 days during the year that have precipitation of 0.01 inch or more.

Showers and thunderstorms account for much of the precipitation during the growing season. Average number of days that have thunderstorms is 55; about one-half of these occur during the peak rainfall period of May through July. Rainfall from these storms is sporadic and variable. If the average precipitation from April to October were evenly distributed through the growing season, it would be adequate in most years. Some years, however, have long dry periods between significant rains. Annual rainfall at Newton during the period 1897–1969 ranged from 16.11 inches in 1956 to 51.50 inches in 1951. It is not unusual for a series of dry years to occur. Part of the 1930's and the years 1952–1956 were periods of severe drought in Harvey County and most of Kansas.

The mean percentage of possible sunshine is 65 to 70, ranging from 60 percent during winter to more than 75 per cent in July. For 65 percent of the days the weather is clear or partly cloudy, and only 35 percent is cloudy.

Snowfall is high in Harvey County, averaging 16 inches per year. Some winter seasons have little snow. It is unusual for more than 25 inches of snow to be reported during a cold season; the heaviest of record is 47½ inches from November 1959 to March 1960.

The continental climate results in fairly wide daily and annual temperature ranges (see table 9). Average monthly temperature varies from 31.0° F. in January to 79.9° in July. Temperature extremes for the period of record at Newton have ranged from −28° to 117°.

The probabilities of the last freeze in spring and the first in fall in the central part of Harvey County are given for five thresholds in table 10. The average freeze-free period is 6 months in length and extends from April 20 to October 23 (*2*). The long growing season usually means little crop loss from freezing weather in the county.

The prevailing wind is southerly. Surface wind records are not available for Harvey County, but records at Wichita indicate the average hourly velocity is 13 to 14 miles per hour. Winds are generally light to moderate in all seasons. Average monthly velocities are lowest from midsummer to early fall and gradually increase to a maximum in spring.

With the exception of deficient rainfall, very high temperatures, or both, in some growing seasons, climatic conditions in Harvey County are generally favorable for growing crops. The percentage of possible sunshine, the long growing season, and the seasonal distribution of precipitation all contribute to a favorable climate for farming.

Farming

Harvey County was organized in 1872. The native vegetation was tall grasses. Plowing of the native sod began in the 1870's. At first, corn was the principal crop, but by the 1880's wheat became the main crop.

Wheat continues to be the main crop in the county. In the 1950's the acreage of grain sorghum increased greatly. By 1960, it had replaced corn as the second most important crop.

The number of farms in 1970 was 997, and the average size was 337 acres.

Most towns have facilities for handling and storing grain, and Newton has a flour mill. Railroads provide transportation of farm products to market. Federal and State highways cross the county, and county and township roads provide access to major highways.

Wheat and sorghum are better suited to the climate of Harvey County than other crops. According to statistics of the Kansas State Board of Agriculture, the principal crops grown in 1966 were wheat, 108,000 acres:

[8] By MERLE J. BROWN, State climatologist, NOAA, National Weather Service.

TABLE 9.—*Temperature and precipitation data*

[From records kept at Newton, Harvey County, Kansas]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have about 4 days with—		Average total	One year in 10 will have—		Days with snow cover of 1.0 inch or more	Average depth of snow on days that have a snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Totals less than—	Totals greater than—		
	°F.	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	41. 6	20. 3	61	3	0. 91	0. 04	1. 64	6	3
February	46. 5	23. 4	66	8	1. 09	0. 11	2. 07	4	3
March	57. 3	32. 1	76	15	1. 80	0. 38	3. 33	2	5
April	67. 8	43. 3	84	30	2. 54	0. 89	5. 79	(1)	2
May	76. 0	52. 9	90	42	4. 41	1. 72	8. 51	0	----------
June	86. 8	63. 2	100	53	4. 48	1. 26	9. 37	0	----------
July	92. 3	67. 4	105	61	3. 60	0. 81	7. 57	0	----------
August	92. 2	66. 8	105	59	3. 33	1. 03	6. 14	0	----------
September	84. 1	58. 5	98	46	3. 70	0. 92	6. 69	0	----------
October	71. 8	46. 9	87	34	2. 21	0. 43	5. 25	0	----------
November	56. 5	33. 1	71	18	1. 38	0. 03	3. 05	(1)	1
December	44. 4	23. 4	63	10	1. 05	0. 09	2. 50	5	3
Year	68. 1	44. 3	[2] 105	[3] −7	30. 50	20. 90	42. 40	18	3

[1] Less than 0.5 day.
[2] Average annual maximum.
[3] Average annual minimum.

TABLE 10.—*Probabilities of last freezing weather in spring and first in fall for central part of Harvey County, Kansas*

Probability	Temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	March 28	April 5	April 10	April 22	May 5.
2 years in 10 later than	March 22	March 30	April 5	April 17	April 30.
5 years in 10 later than	March 10	March 20	March 27	April 7	April 20.
Fall:					
1 year in 10 earlier than	November 13	November 6	October 30	October 17	October 9.
2 years in 10 earlier than	November 19	November 11	November 3	October 22	October 13.
5 years in 10 earlier than	December 1	November 22	November 13	October 31	October 23.

grain sorghum, 46,000 acres; alfalfa hay, 18,300 acres; soybeans, 7,800 acres; forage sorghum, 5,500 acres; corn for silage, 4,300 acres; barley, 4,200 acres; oats, 3,480 acres; alfalfa seed, 2,000 acres; corn for grain, 1,500 acres; and rye, 1,060.

Livestock is an important source of income in Harvey County. Of the kinds of livestock raised, beef cattle are the most important as a source of income. According to statistics of the Kansas State Board of Agriculture, the approximate numbers of livestock on farms in 1966 were beef cattle, 45,500; milk cows, 4,500; hogs, 15,500; sheep and lambs, 30,000; and chickens, 170,000. About 48 percent of farm income in 1966 came from the sale of livestock and livestock products.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Blowout. An excavation product by wind action in loose soil, usually sand.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of materials commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Emergency tillage. Cultivation by listing, ridging, duckfooting, chiseling, or other means to roughen the soil surface for temporary control of wind erosion.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Habitat. The natural abode of a plant or animal; it refers to the kind of environment in which a plant or animal normally lives as opposed to its range, or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to relatively level plots surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops, or in orchards, to confine the flow of water to one direction.

Furrow.—Water is applied in small ditches made by cultivation implements used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Irrigation water, released at high points, flows onto the field without controlled distribution.

Leaching. The removal of soluble materials from soils by percolating water.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc and perhaps other elements obtained from the soil and carbon, hydrogen, and oxygen obtained largely from the air and water, are plant nutrients.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Range. Land that, for the most part, produces native plants suitable for grazing by livestock; includes land on which there are some trees.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff.

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; or one that contains harmful salts and has a highly alkaline reaction; or one that contains harmful salts and exchangeable sodium and is strongly alkaline in reaction. The salts, exchangeable sodium, and alkaline reaction occur in the soil in such location that growth of most crops is less than normal.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from erosion and blowing after harvest, during preparation of a seedbed for the next crop, and during the early growing period of a new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon; has no depth limit.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable

state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland. Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along a river.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents. These changes result in more or less complete disintegration and decomposition of the rock.

Wind stripcropping. Growing crops in strips that run crosswise to the general direction of the prevailing wind and without strict adherence to the contour of the land.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Windbreak groups are described on page 33. Other information is given in tables as follows:

Acreage and extent, table 1, page 9.
Predicted yields, table 2, page 29.
Soil limitations for recreational uses, table 5, page 35.
Engineering uses of the soils, table 6, page 38, and table 7, page 40.

Map symbol	Mapping unit	Page	Capability unit	Range site		Windbreak group
			Symbol	Name	Page	Number
Ad	Alluvial land, broken	8	VIIw-1	----------	----	---
Ba	Breaks-Alluvial land complex	8	VIe-3	----------	----	---
	Breaks part	--	------	Clay Upland	30	---
	Alluvial land	--	------	Loamy Lowland	31	---
Ca	Carwile fine sandy loam	9	IIw-2	Sandy	32	3
Cc	Clark clay loam, 1 to 3 percent slopes	10	IIIe-5	Limy Upland	31	2
Cd	Clime silty clay, 1 to 3 percent slopes	11	IIIe-3	Limy Upland	31	8
Ce	Clime silty clay, 3 to 6 percent slopes	11	IVe-1	Limy Upland	31	8
Cf	Clime silty clay, 2 to 6 percent slopes, eroded	11	VIe-4	Limy Upland	31	8
Cm	Clime complex, 6 to 12 percent slopes	11	VIe-4	Limy Upland	31	8
Cr	Crete silt loam, 0 to 1 percent slopes	12	IIs-2	Loamy Upland	31	2
Ct	Crete silt loam, 1 to 3 percent slopes	12	IIe-2	Loamy Upland	31	2
De	Detroit silty clay loam	14	I-2	Loamy Lowland	31	7
Dp	Dillwyn-Plevna complex	14	Vw-1	Subirrigated	32	9
Dt	Dillwyn-Tivoli complex	14	VIe-1	----------	----	---
	Dillwyn part	--	------	Subirrigated	32	9
	Tivoli part	--	------	Sands	31	6
Du	Drummond complex	16	Vw-2	Saline Lowland	31	9
Fa	Farnum fine sandy loam, 0 to 1 percent slopes	16	I-3	Sandy	32	4
Fc	Farnum loam, 0 to 1 percent slopes	16	I-1	Loamy Upland	31	2
Fd	Farnum loam, 1 to 3 percent slopes	16	IIe-1	Loamy Upland	31	2
Fe	Farnum loam, 3 to 6 percent slopes	17	IIIe-2	Loamy Upland	31	2
Fs	Farnum-Slickspots complex	17	IVs-1	----------	----	---
	Farnum part	--	------	Loamy Upland	31	2
	Slickspots part	--	------	Saline Lowland	31	9
Gc	Geary silt loam, 0 to 1 percent slopes	17	I-1	Loamy Upland	31	2
Gd	Geary silt loam, 1 to 3 percent slopes	18	IIe-1	Loamy Upland	31	2
Ge	Geary silt loam, 3 to 6 percent slopes	18	IIIe-2	Loamy Upland	31	2
Go	Goessel silty clay, 0 to 1 percent slopes	18	IIs-1	Clay Upland	30	1
Gs	Goessel silty clay, 1 to 2 percent slopes	18	IIIe-1	Clay Upland	30	1
Ho	Hobbs silt loam 1/	19	IIw-1	Loamy Lowland	31	7
Ir	Irwin silty clay loam, 1 to 3 percent slopes	20	IIIe-1	Clay Upland	30	1
Is	Irwin silty clay loam, 3 to 6 percent slopes	20	IIIe-6	Clay Upland	30	1
It	Irwin silty clay loam, 2 to 6 percent slopes, eroded	20	IVe-2	Clay Upland	30	1
Ka	Kaski loam	22	IIw-1	Loamy Lowland	31	7
La	Ladysmith silty clay loam, 0 to 1 percent slopes	22	IIs-1	Clay Upland	30	1
Lb	Ladysmith silty clay loam, 1 to 2 percent slopes	22	IIIe-1	Clay Upland	30	1
Ld	Ladysmith-Slickspots complex	22	IVs-1	----------	----	---
	Ladysmith part	--	------	Clay Lowland	30	1
	Slickspots part	--	------	Saline Lowland	31	9
Le	Lesho loam	23	IIIw-1	Subirrigated	32	7
Na	Naron fine sandy loam, 0 to 1 percent slopes	24	I-3	Sandy	32	4
Nb	Naron fine sandy loam, 1 to 4 percent slopes	24	IIe-3	Sandy	32	4
Pa	Pratt loamy fine sand, 1 to 5 percent slopes	25	IIIe-4	Sands	31	5
Pc	Pratt-Carwile complex	25	IIIe-4	----------	----	---
	Pratt part	--	------	Sands	31	5
	Carwile part	--	------	Sandy	32	3
Pt	Pratt-Tivoli loamy fine sands	25	VIe-2	Sands	31	---
	Pratt part	--	------	----------	----	5
	Tivoli part	--	------	----------	----	6
Ro	Rosehill silty clay, 1 to 3 percent slopes	26	IIIe-3	Clay Upland	30	8
Rs	Rosehill silty clay, 3 to 6 percent slopes	26	IVe-1	Clay Upland	30	8
Sm	Smolan silty clay loam, 1 to 3 percent slopes	26	IIe-2	Loamy Upland	31	2
Tv	Tivoli fine sand	27	VIIe-1	Choppy Sands	30	6

1/ Hobbs soils, as mapped and correlated in this survey, are now classified as Hord soils. They are Cumulic Hapludolls, fine-silty, mixed, mesic.

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

KANSAS AGRICULTURAL EXPERIMENT STATION

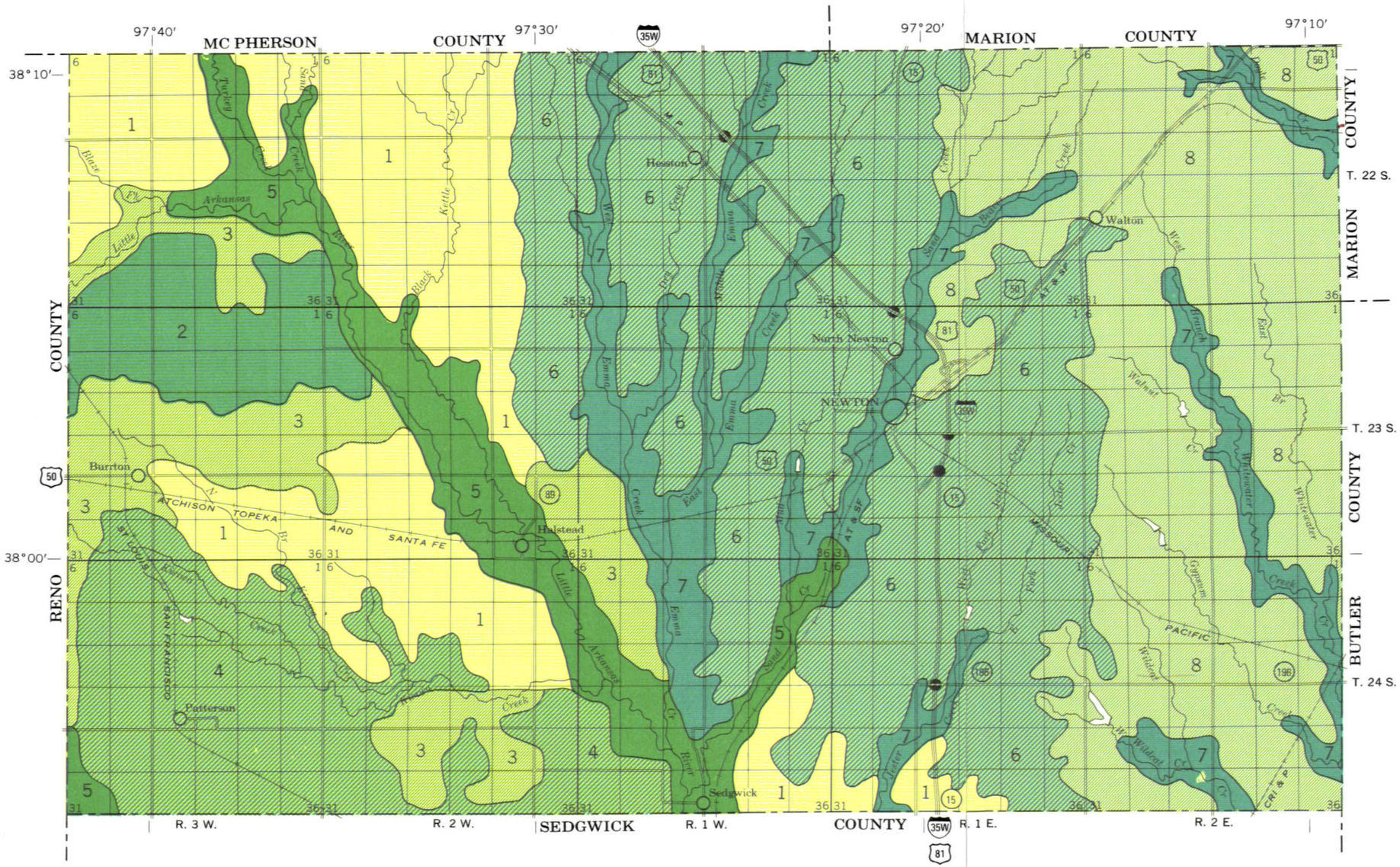
GENERAL SOIL MAP

HARVEY COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

N



SOIL ASSOCIATIONS *

1 Crete-Ladysmith association: Deep, nearly level to gently sloping, moderately well drained to well drained silt loams and silty clay loams on uplands

2 Dillwyn-Tivoli association: Deep, nearly level, somewhat poorly drained loamy fine sands and deep, hummocky, excessively drained fine sands on uplands

3 Carwile-Pratt association: Deep, nearly level, somewhat poorly drained fine sandy loams and deep, undulating, well-drained loamy fine sands on uplands

4 Farnum-Slickspots-Naron association: Deep, nearly level to gently sloping, well-drained to somewhat poorly drained loams and fine sandy loams on uplands

5 Detroit-Hobbs association: Deep, nearly level, moderately well drained to well drained silty clay loams and silt loams on flood plains

6 Ladysmith-Goessel association: Deep, nearly level to gently sloping, moderately well drained silty clay loams and silty clays on uplands

7 Farnum-Hobbs-Geary association: Deep, nearly level to gently sloping, well-drained loams and silt loams on uplands and flood plains

8 Irwin-Rosehill-Clime association: Deep and moderately deep, gently sloping to sloping, well-drained silty clay loams and silty clays on uplands

* Texture in the name of the associations refers to the surface layer of the major soils unless indicated otherwise.

Compiled 1972

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

INDEX TO MAP SHEETS

HARVEY COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

N

97°40′ 97°30′ 97°20′ 97°10′

38°10′— 38°00′—

MC PHERSON COUNTY | MARION COUNTY | RENO COUNTY | SEDGWICK COUNTY | BUTLER COUNTY

T. 22 S. T. 23 S. T. 24 S.

R. 3 W. R. 2 W. R. 1 W. R. 1 E. R. 2 E.

Hesston Walton North Newton NEWTON Halstead Burrton Patterson Sedgwick

Inset, sheet 7

Inset, sheet 20

Inset, sheet 33

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

SYMBOL	NAME
Ad	Alluvial land, broken
Ba	Breaks-Alluvial land complex
Ca	Carwile fine sandy loam
Cc	Clark clay loam, 1 to 3 percent slopes
Cd	Clime silty clay, 1 to 3 percent slopes
Ce	Clime silty clay, 3 to 6 percent slopes
Cf	Clime silty clay, 2 to 6 percent slopes, eroded
Cm	Clime complex, 6 to 12 percent slopes
Cr	Crete silt loam, 0 to 1 percent slopes
Ct	Crete silt loam, 1 to 3 percent slopes
De	Detroit silty clay loam
Dp	Dillwyn-Plevna complex
Dt	Dillwyn-Tivoli complex
Du	Drummond complex
Fa	Farnum fine sandy loam, 0 to 1 percent slopes
Fc	Farnum loam, 0 to 1 percent slopes
Fd	Farnum loam, 1 to 3 percent slopes
Fe	Farnum loam, 3 to 6 percent slopes
Fs	Farnum-Slickspots complex
Gc	Geary silt loam, 0 to 1 percent slopes
Gd	Geary silt loam, 1 to 3 percent slopes
Ge	Geary silt loam, 3 to 6 percent slopes
Go	Goessel silty clay, 0 to 1 percent slopes
Gs	Goessel silty clay, 1 to 2 percent slopes
Ho	Hobbs silt loam
Ir	Irwin silty clay loam, 1 to 3 percent slopes
Is	Irwin silty clay loam, 3 to 6 percent slopes
It	Irwin silty clay loam, 2 to 6 percent slopes, eroded
Ka	Kaski loam
La	Ladysmith silty clay loam, 0 to 1 percent slopes
Lb	Ladysmith silty clay loam, 1 to 2 percent slopes
Ld	Ladysmith-Slickspots complex
Le	Lesho loam
Na	Naron fine sandy loam, 0 to 1 percent slopes
Nb	Naron fine sandy loam, 1 to 4 percent slopes
Pa	Pratt loamy fine sand, 1 to 5 percent slopes
Pc	Pratt-Carwile complex
Pt	Pratt-Tivoli loamy fine sands
Ro	Rosehill silty clay, 1 to 3 percent slopes
Rs	Rosehill silty clay, 3 to 6 percent slopes
Sm	Smolan silty clay loam, 1 to 3 percent slopes
Tv	Tivoli fine sand

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness: Stony, Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Saline spot
- Shale
- Borrow pit (B.P.)

2 230 000 FEET

MC PHERSON COUNTY

R. 3 W.

RENO COUNTY

545 000 FEET

T. 22 S.

HEBRON CEMETERY

Blaze Fork

Turkey Creek

(Joins sheet 2)

(Joins sheet 8)

2 250 000 FEET

535 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS — SHEET NUMBER 2

N

R. 3 W. | R. 2 W.

MC PHERSON COUNTY

2 275 000 FEET

550 000 FEET

T. 22 S.

(Joins sheet 1)

(Joins sheet 3)

535 000 FEET

2 255 000 FEET

(Joins sheet 9)

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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Land division corners are approximately positioned on this map.

2 280 000 FEET

MC PHERSON COUNTY

R. 2 W. | R. 1 W.

550 000 FEET

T. 22 S.

Cattle Creek

Black Creek

MISSOURI PACIFIC

West Emma Creek

(Joins sheet 2)

(Joins sheet 4)

(Joins sheet 10)

2 300 000 FEET

535 000 FEET

N

1 Mile

5 000 Feet

Scale 1:20 000

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS — SHEET NUMBER 4

N

Scale 1:20 000

1 Mile 0 1/4 1/2 3/4 1

5 000 Feet 0 1 000 2 000 3 000 4 000 5 000

R. 1 W. | R. 1 E.

MC PHERSON COUNTY | MARION COUNTY

2 325 000 FEET

550 000 FEET

535 000 FEET

2 305 000 FEET

(Joins sheet 3)

(Joins sheet 11)

(Joins sheet 5)

T. 22 S.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS — SHEET NUMBER 6

6

N

R. 1 E. | R. 2 E.

MARION COUNTY

2 375 000 FEET

550 000 FEET

T. 22 S.

(Joins sheet 5)

(Joins sheet 7)

(Joins sheet 13)

540 000 FEET

2 355 000 FEET

Double Creek

Beaver Creek

ATCHISON TOPEKA AND SANTA FE

1 Mile

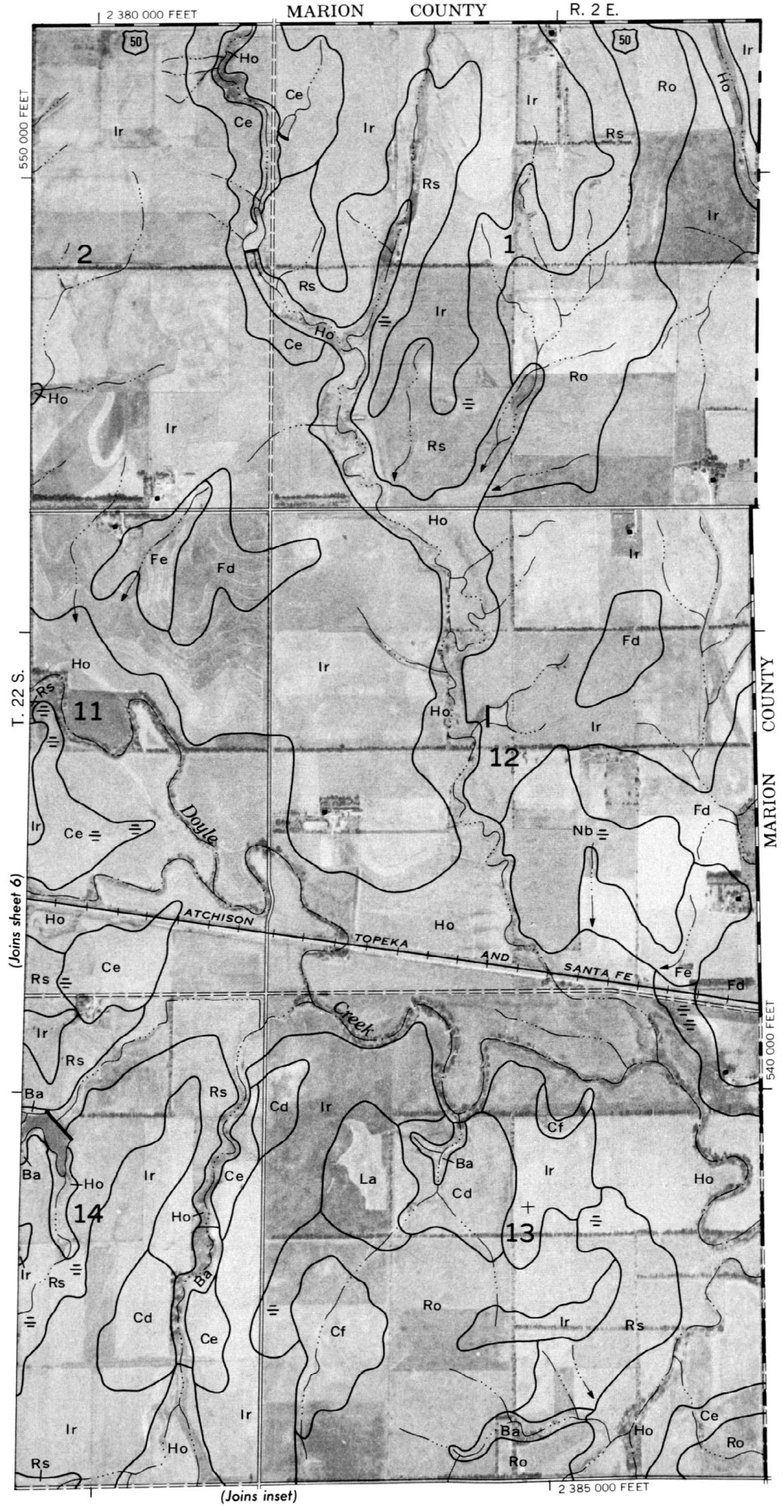
5 000 Feet

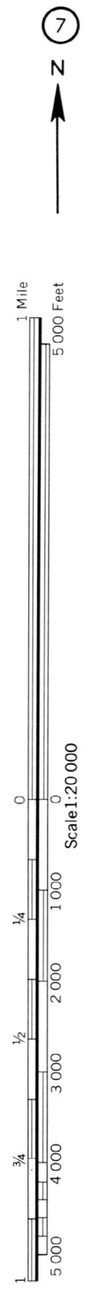
Scale 1:20 000

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.





Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

(8)

N

R. 3 W.

(Joins sheet 1)

2 250 000 FEET

T. 22 S.

530 000 FEET

520 000 FEET

2 230 000 FEET

(Joins sheet 14)

(Joins sheet 9)

RENO COUNTY

Scale 1:20 000

1 Mile 5 000 Feet

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

1 5 000

Land division corners are approximately positioned on this map.

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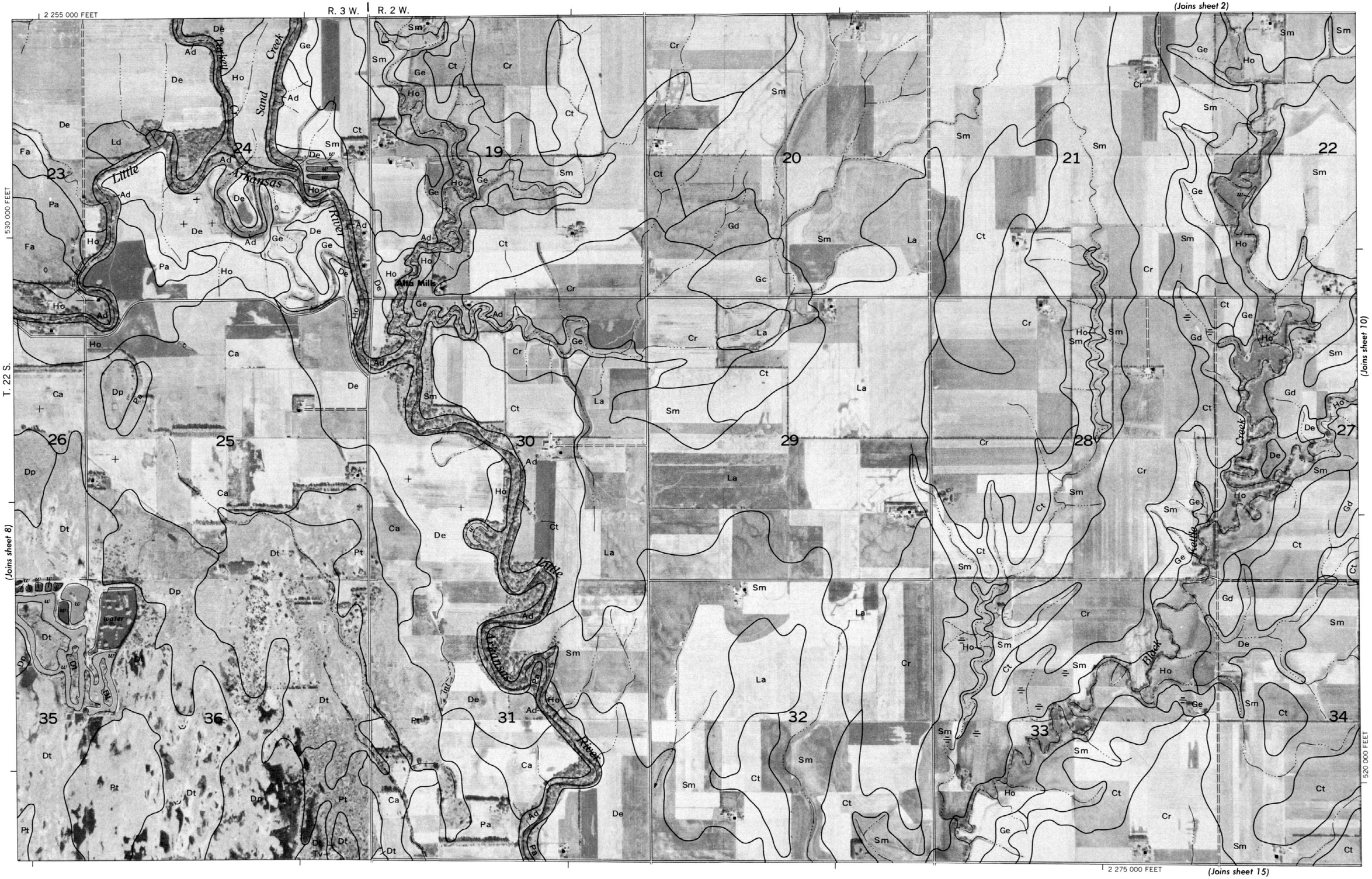
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.



Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

9

N

1 Mile
5 000 Feet

Scale 1:20 000
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000

HARVEY COUNTY, KANSAS — SHEET NUMBER 10

(10)

N

(Joins sheet 3)

R. 2 W. | R. 1 W.

2 300 000 FEET

530 000 FEET

520 000 FEET

2 280 000 FEET

(Joins sheet 9)

(Joins sheet 16)

(Joins sheet 11)

T. 22 S.

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

22 23 24 19 20 21

27 26 25 30 29 28

34 35 36 31 32 33

Creek

Emma Creek

Dry Creek

Wksf

Fc

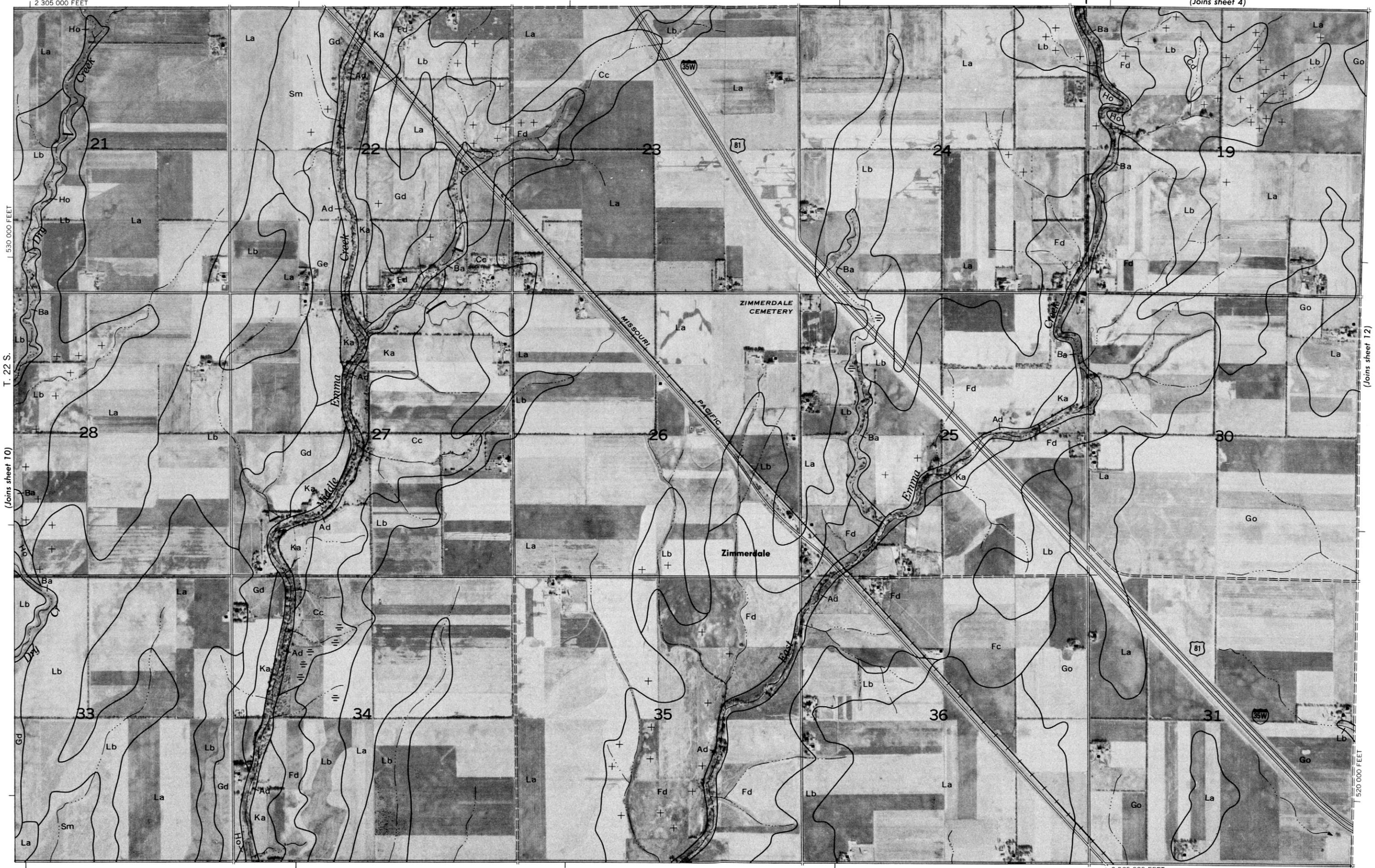
South Garden School

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS — SHEET NUMBER 11



11

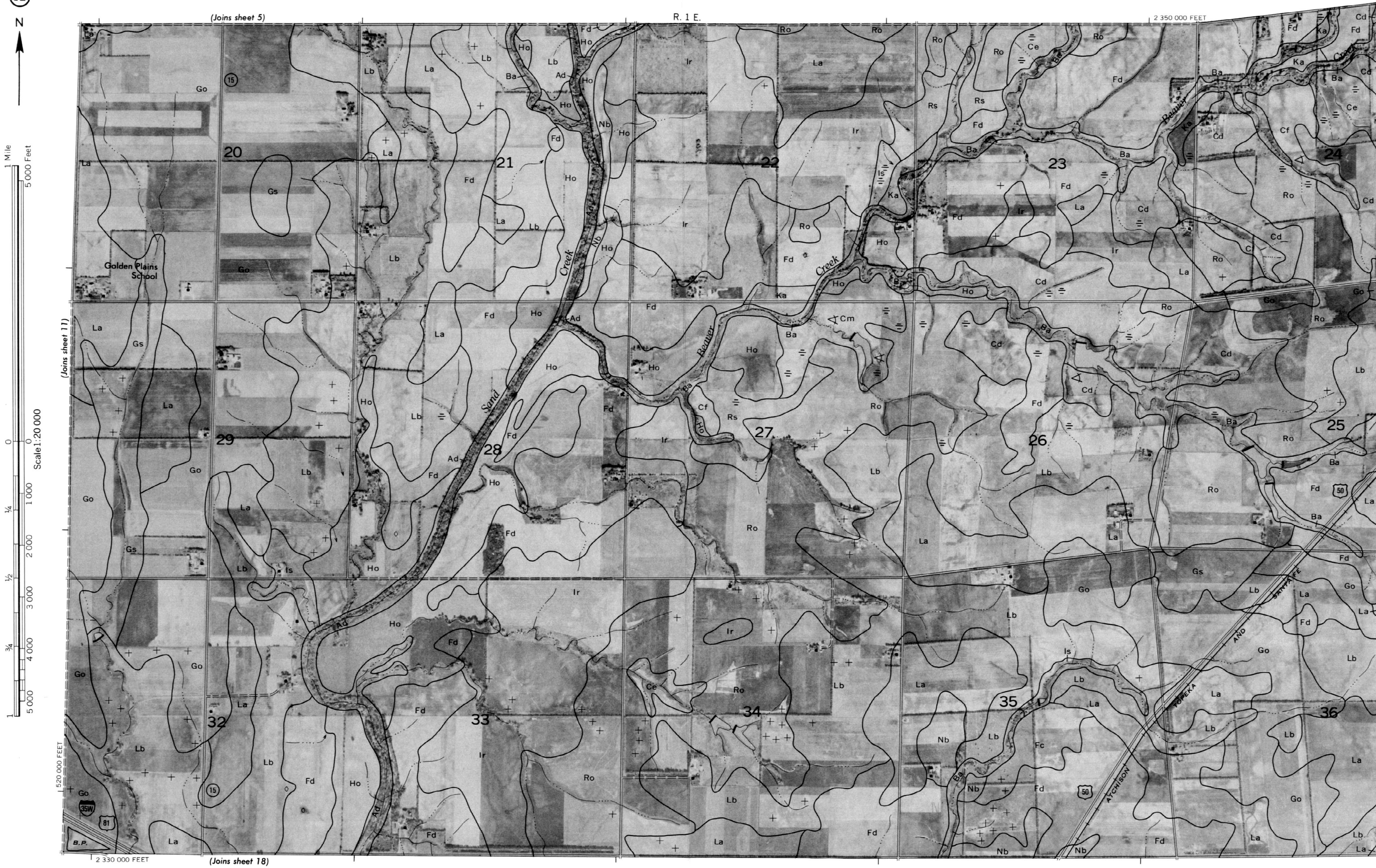
N

1 Mile
5 000 Feet
Scale 1:20 000

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS — SHEET NUMBER 12



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

R. 1 E. | R. 2 E.
2 355 000 FEET

535 000 FEET

T. 22 S.

(Joins sheet 6)

(Joins sheet 12)

(Joins inset, sheet 7)

(Joins sheet 19)

2 375 000 FEET

520 000 FEET

13

N

1 Mile
5 000 Feet

Scale 1:20 000

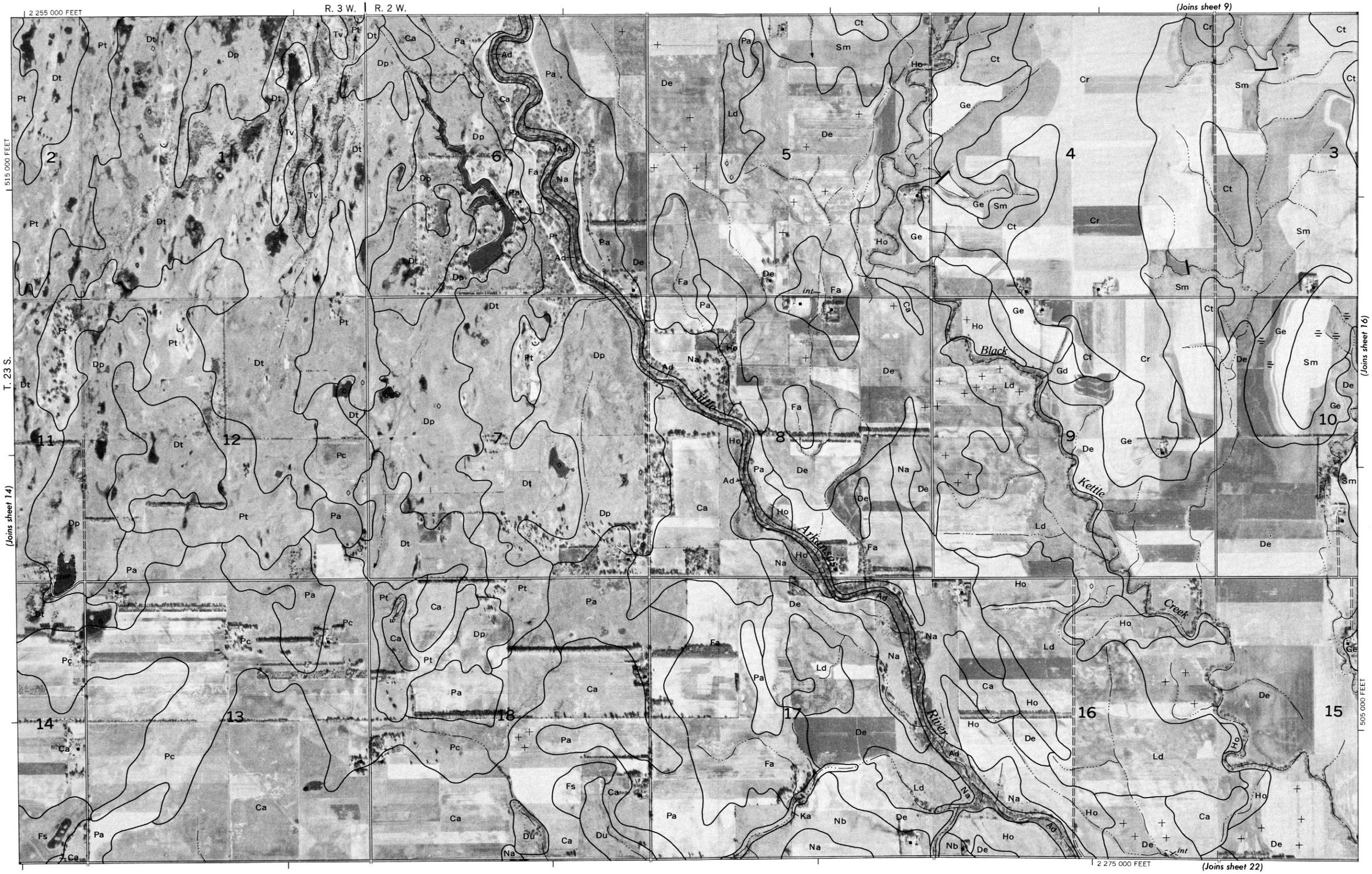
1 5 000 ¾ 4 000 ½ 3 000 ¼ 2 000 0 1 000 0

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

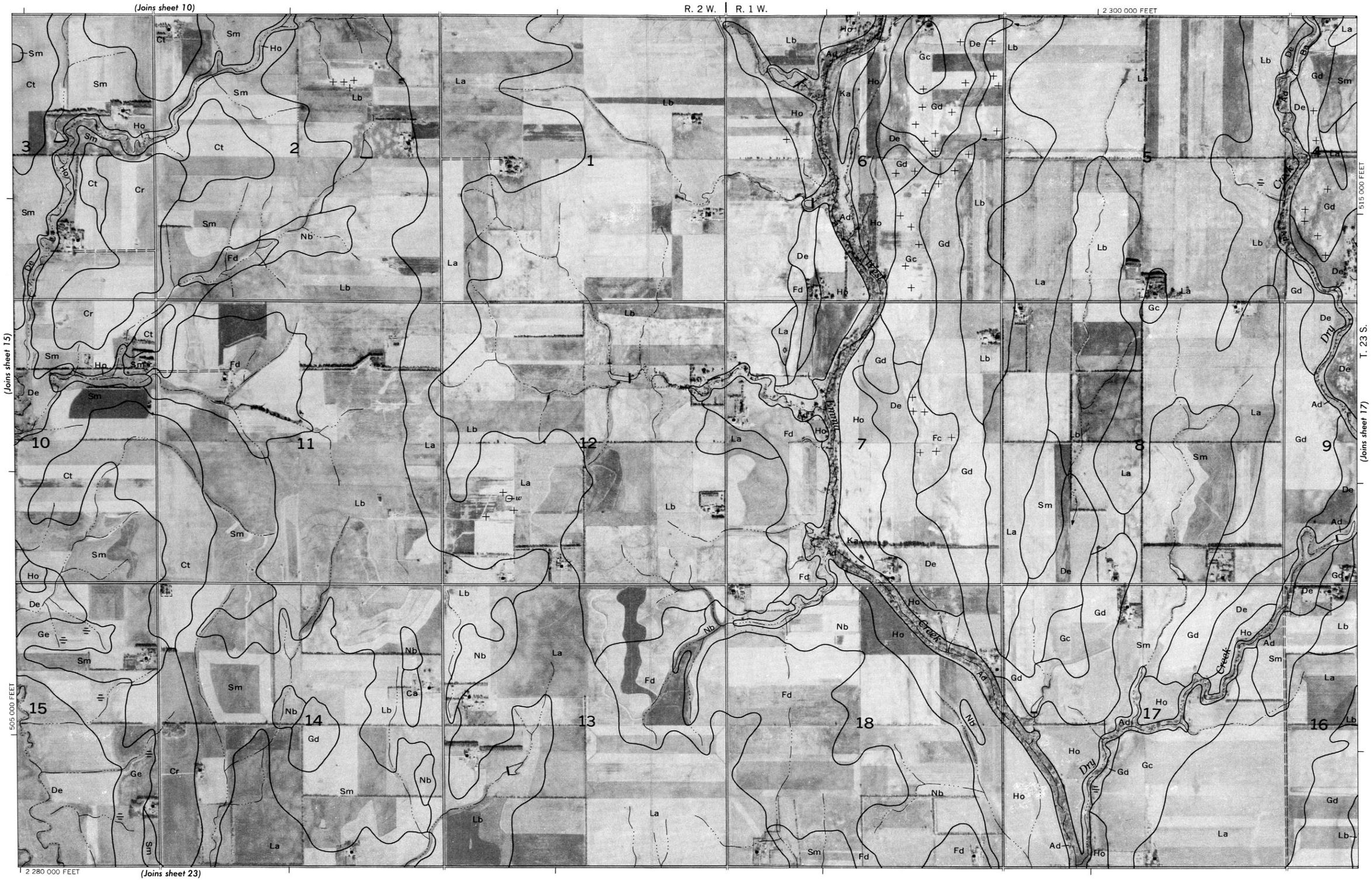


Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

15

N

1 Mile
5 000 Feet
Scale 1:20 000
1/4 1/2 3/4 1
1 000 2 000 3 000 4 000 5 000



1 Mile
5 000 Feet
Scale 1:20 000
0 0
¼ 1 000
½ 2 000
¾ 3 000
1 4 000
5 000

Land division corners are approximately positioned on this map.

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Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

2 305 000 FEET

R. 1 W. | R. 1 E.

(Joins sheet 11)

17

N

T. 23 S.

515 000 FEET

(Joins sheet 16)

(Joins sheet 18)

505 000 FEET

2 325 000 FEET

(Joins sheet 24)

MISSOURI PACIFIC

Middle Creek

Emma Creek

East Dry Creek

Dry Creek

Mud Creek

SAND CREEK

NEWTON
(county seat)

1 Mile
5 000 Feet
Scale 1:20 000

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

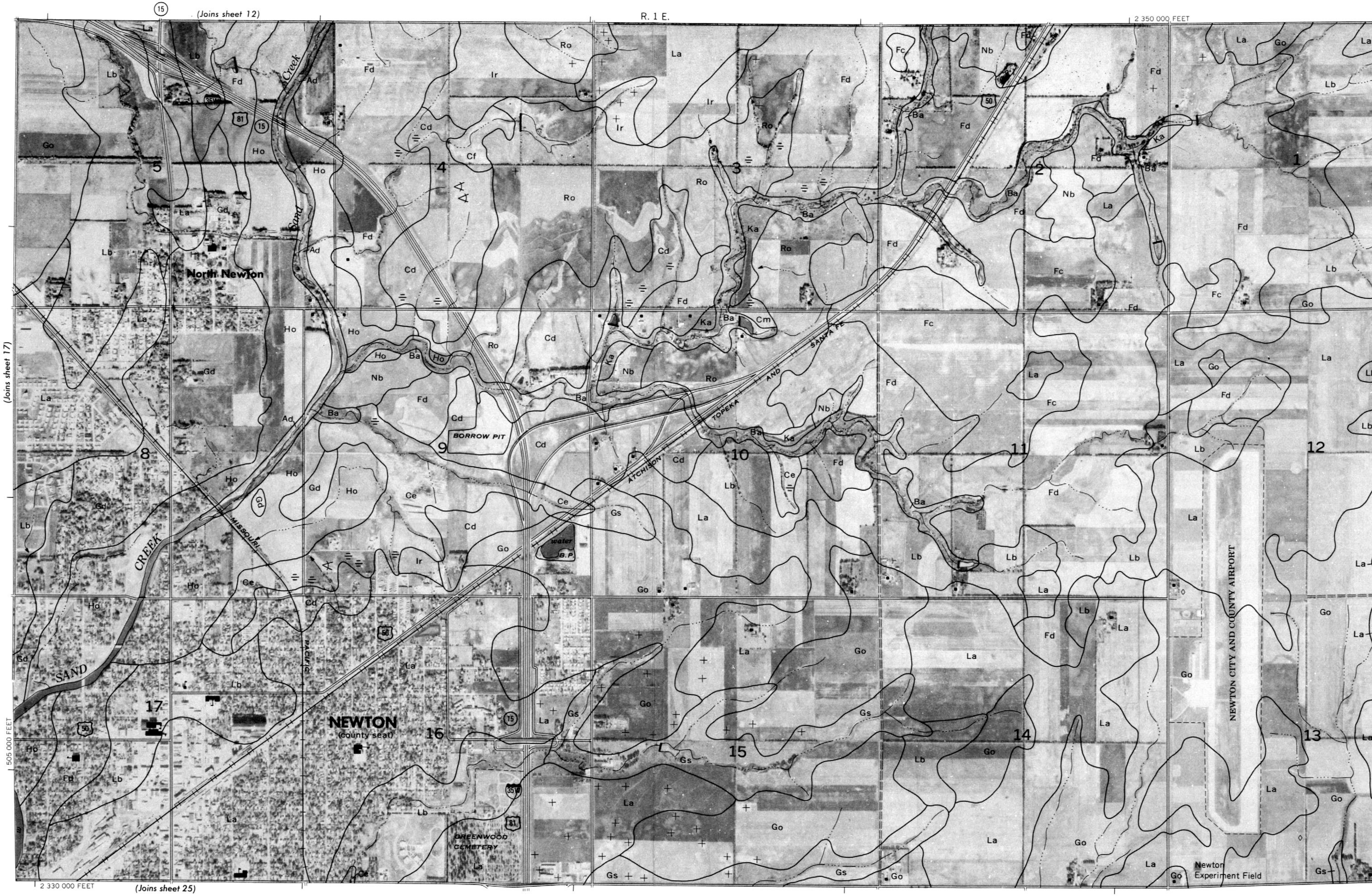
HARVEY COUNTY, KANSAS — SHEET NUMBER 18

N

Scale 1:20 000

1 Mile — ¾ — ½ — ¼ — 0

5 000 Feet — 4 000 — 3 000 — 2 000 — 1 000 — 0



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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Land division corners are approximately positioned on this map.

R. 1 E. | R. 2 E.

2 355 000 FEET

515 000 FEET

T. 23 S.

(Joins sheet 13)

(Joins sheet 18)

(Joins sheet 20)

(Joins sheet 26)

2 375 000 FEET

505 000 FEET

East Branch Whitewater

West Branch Whitewater

Walnut Creek

Whitewater

Ho Creek

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

19

N

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

N

1 Mile
5 000 Feet
0
0
1:20 000
Scale 1:20 000
¼
1 000
½
2 000
¾
3 000
1
4 000
5 000

4 000 AND 5 000-FOOT GRID TICKS

(Joins inset, sheet 7) R. 2 E. 2 385 000 FEET

520 000 FEET

T. 23 S.

(Joins sheet 19)

BUTLER COUNTY

505 000 FEET

2 380 000 FEET

(Joins inset)

(Joins lower left) R. 2 E. 2 385 000 FEET

500 000 FEET

(Joins sheet 26)

490 000 FEET

2 381 000 FEET

(Joins sheet 33)

Grace Hill Church

Whitewater River

Branch

Creek

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

HARVEY COUNTY, KANSAS — SHEET NUMBER 21

2 230 000 FEET

R. 3 W.

(Joins sheet 14)

500 000 FEET

T. 23 S.

RENO COUNTY

(Joins sheet 22)

(Joins sheet 27)

1 490 000 FEET

2 255 000 FEET

N

Scale 1:20 000

1 Mile 5 000 Feet

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

22

N

R. 3 W. | R. 2 W.

(Joins sheet 15)

(Joins sheet 21)

(Joins sheet 23)

(Joins sheet 28)

2 275 000 FEET

2 260 000 FEET

490 000 FEET

500 000 FEET

T. 23 S.

Scale 1:20 000

1 Mile 5 000 Feet

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

1¼ 5 000

Paxton

Grace Church

ATCHISON TOPEKA AND SANTA FE

Little Arkansas River

Kisinger Cr.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS — SHEET NUMBER 23

2 280 000 FEET — R. 2 W. — R. 1 W. — (Joins sheet 16)

500 000 FEET

T. 23 S.

(Joins sheet 22)

(Joins sheet 24)

(Joins sheet 29)

2 305 000 FEET

1 490 000 FEET

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

Scale 1:20 000

1 Mile

5 000 Feet

N

(Joins sheet 17)

R. 1 W. | R. 1 E.

2 325 000 FEET

500 000 FEET

T. 23 S.

(Joins sheet 23)

(Joins sheet 25)

1 Mile

5 000 Feet

0 Scale 1:20 000

1 000 ¼ 2 000 ½ 3 000 ¾ 4 000 1 5 000

490 000 FEET

(Joins sheet 30)

2 310 000 FEET

Middle Emma Creek

East Ad Creek

Mud Creek

Sand Creek

SEWAGE DISPOSAL

ATCHISON TOPEKA AND SANTA FE

Van Arsdale

21 22 23 24 19 28 27 26 25 30 33 34 35 36 31

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

2 330 000 FEET

R. 1 E.

(Joins sheet 18)

500 000 FEET

NEWTON
(county seat)

ST MARYS CEMETERY

BORROW PIT

MISSOURI PACIFIC

Creek

Fork

Jester

West

East

T. 23 S.

(Joins sheet 24)

(Joins sheet 26)

(Joins sheet 31)

2 350 000 FEET

1 490 000 FEET

N

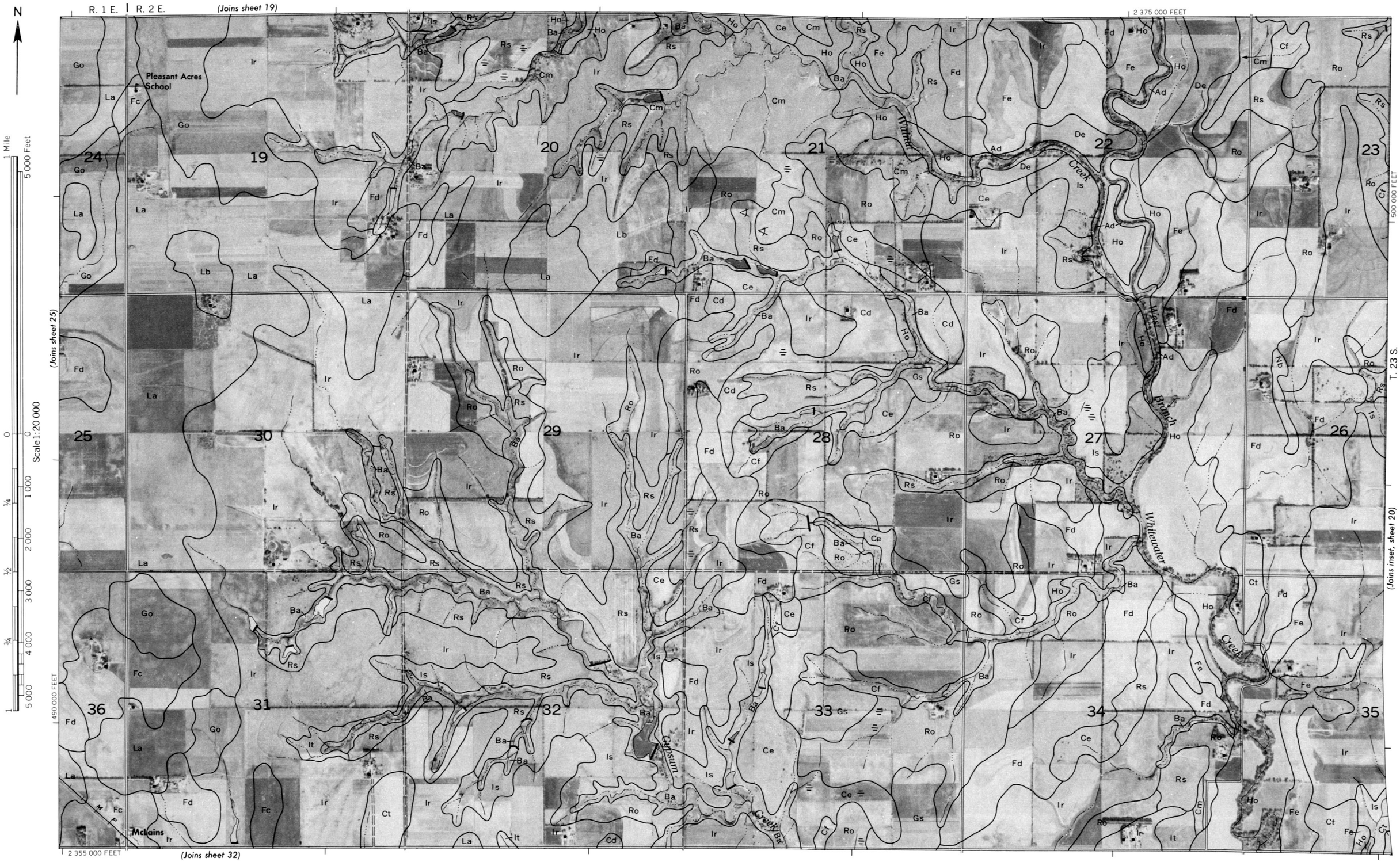
1 Mile

5 000 Feet

Scale 1:20 000

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

N

2 230 000 FEET

485 000 FEET

R. 3 W.

(Joins sheet 21)

COUNTY T. 24 S.

RENO

(Joins sheet 28)

475 000 FEET

(Joins sheet 34)

2 255 000 FEET

1 Mile

5 000 Feet

Scale 1:20 000

1/4 1/2 3/4

1 000 2 000 3 000 4 000 5 000

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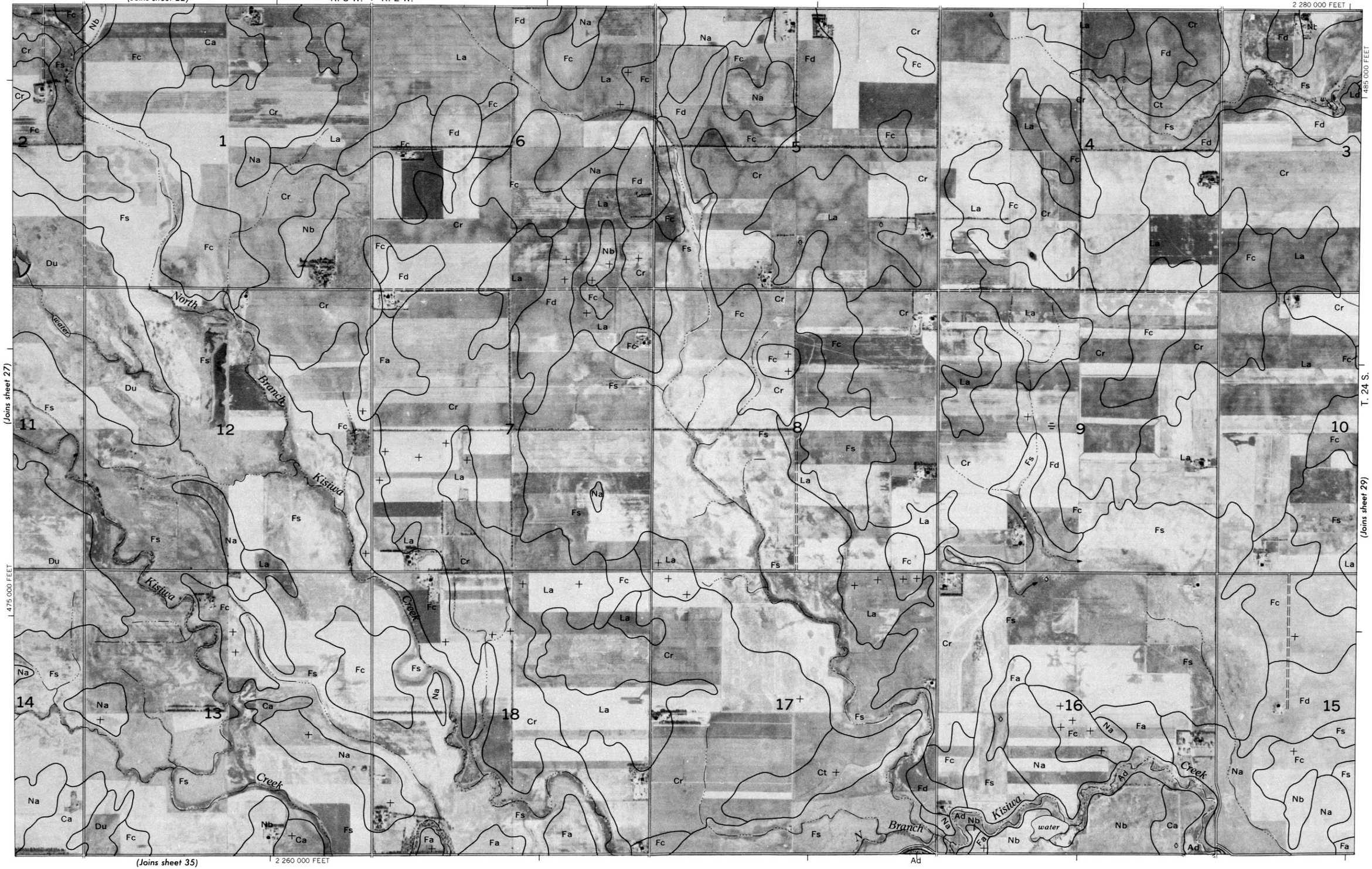
Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.



Land division corners are approximately positioned on this map.

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This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

2 285 000 FEET

485 000 FEET

R. 2 W. | R. 1 W.

(Joins sheet 23)

T. 24 S.

(Joins sheet 28)

(Joins sheet 30)

(Joins sheet 36)

2 305 000 FEET

475 000 FEET

Halstead

Little Arkansas River

Arkansas River

Emma Creek

Kisiwa Creek

29

N

1 Mile

5 000 Feet

Scale 1:20 000

0 5 000 1 000 2 000 3 000 4 000

¼ ½ ¾ 1

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

30

N

Scale 1:20 000

1 Mile 5 000 Feet

0 0

¼ 1 000

½ 2 000

¾ 4 000

1 5 000

(Joins sheet 24)

(Joins sheet 29)

(Joins sheet 37)

(Joins sheet 31)

R. 1 W. | R. 1 E.

T. 24 S.

2 325 000 FEET

1 485 000 FEET

475 000 FEET

2 310 000 FEET

KEMPER CEMETERY

Van Arsdale

Putnam

Mud Creek

Sand Creek

Sand Creek

SANTA FE

TOPEKA AND ATCHISON

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

(Joins sheet 30)

2 330 000 FEET

485 000 FEET

T. 24 S.

R. 1 E.

(Joins sheet 25)

(Joins sheet 32)

(Joins sheet 38)

475 000 FEET

2 355 000 FEET

Suncrest School

BORROW PIT

water

Jester Creek

West Fork Jester Creek

East Fork Jester Creek

West Fork Wildcat Creek

Wildcat Creek

35W

81

15

196

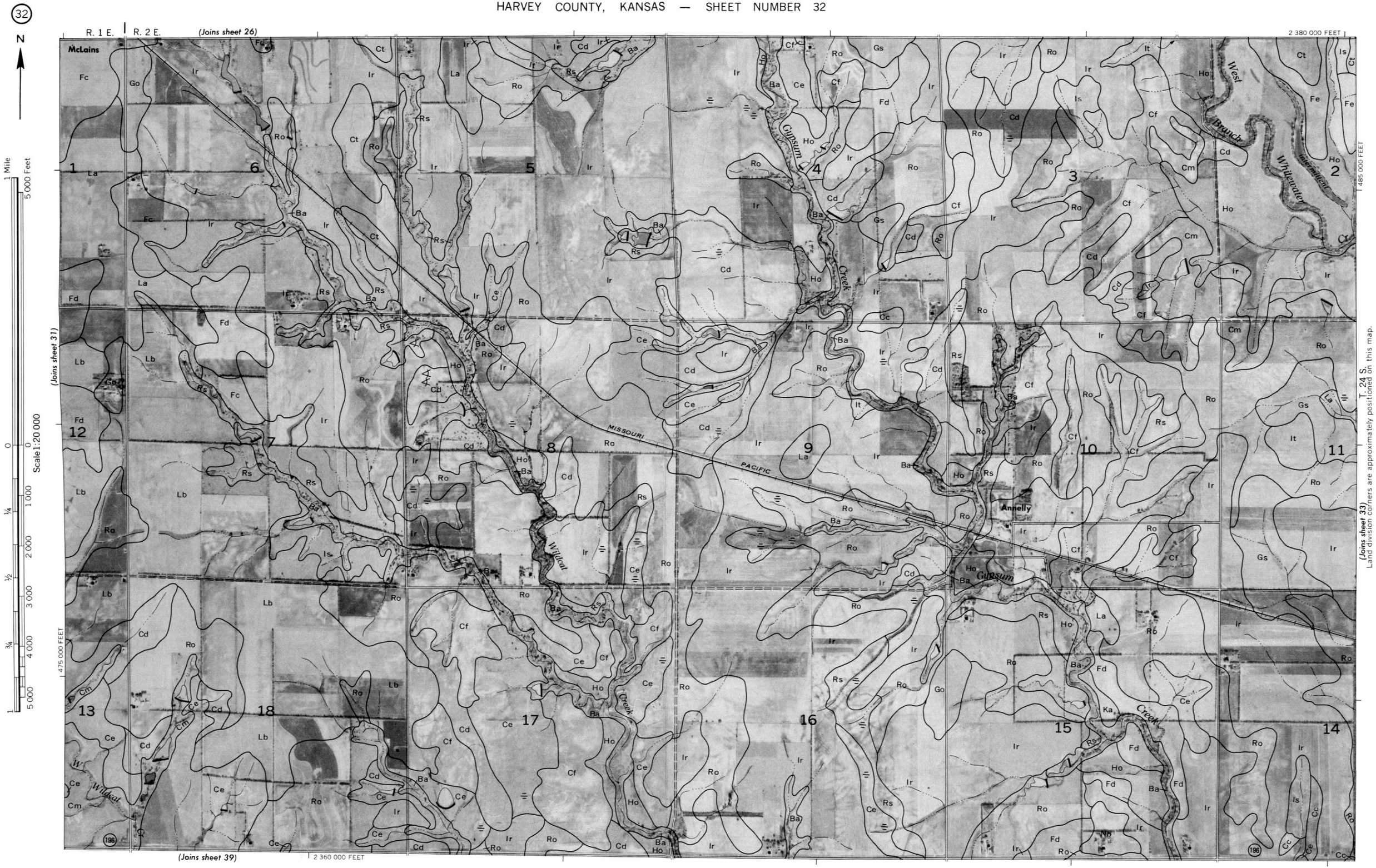
N

1 Mile

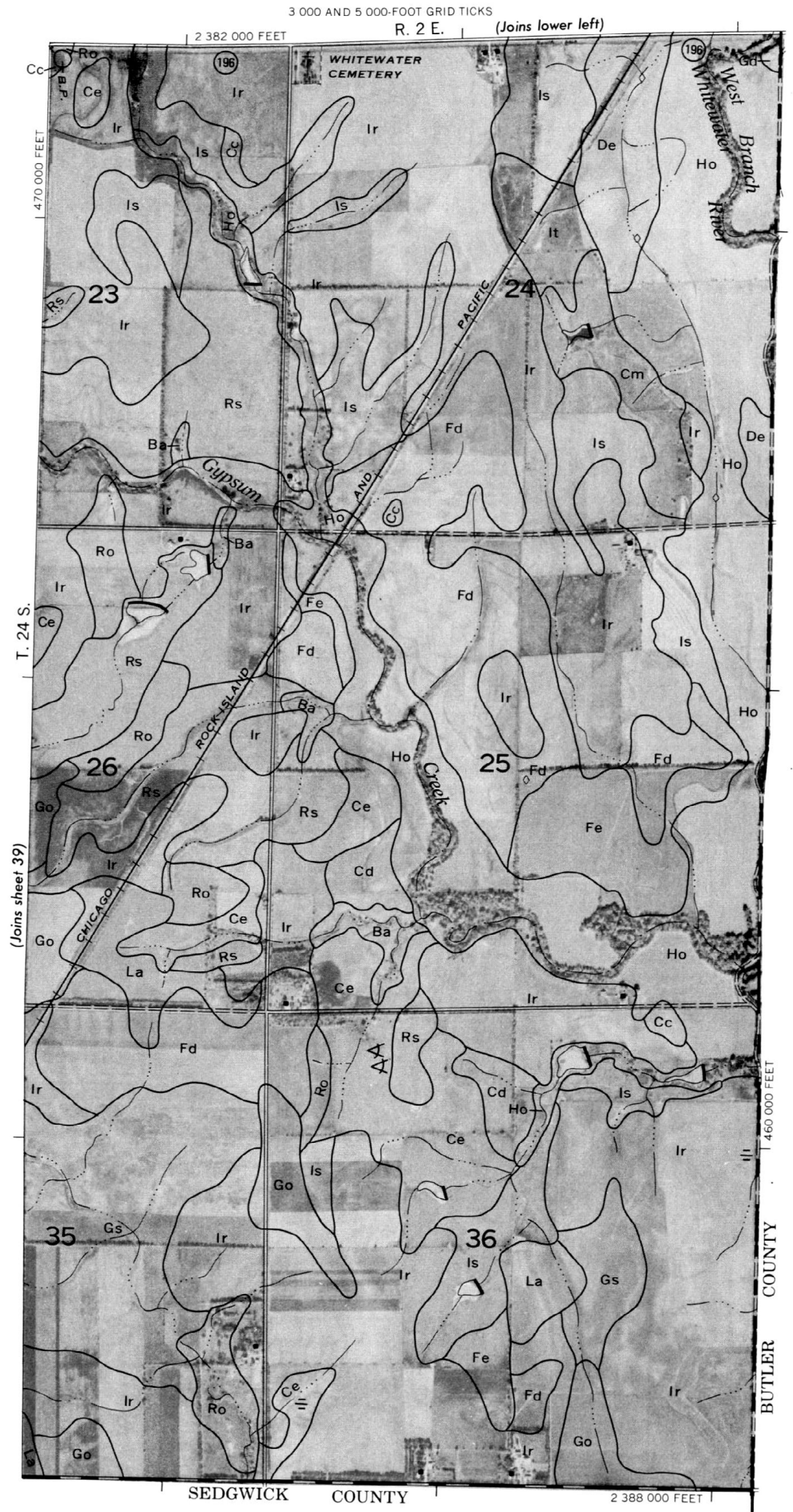
5 000 Feet

Scale 1:20 000

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.


32
N
R. 1 E.
R. 2 E.
(Joins sheet 26)
2 380 000 FEET
McLains
Annelly
Gypsum
Creek
West Branch Whitewater Intermittent
Wildcat
Creek
MISSOURI PACIFIC
1 Mile
5 000 Feet
Scale 1:20 000
(Joins sheet 31)
475 000 FEET
(Joins sheet 39)
2 360 000 FEET
485 000 FEET
T. 24 S.
(Joins sheet 33)
Land division corners are approximately positioned on this map.
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS — SHEET NUMBER 33



33

N

1 Mile
5 000 Feet

Scale 1:20 000

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

(34)

N

(Joins sheet 27)

R. 3 W.

2 255 000 FEET

470 000 FEET

T. 24 S.

1 Mile

5 000 Feet

Scale 1:20 000

0 0

¼ 1 000

½ 2 000

¾ 3 000

1 4 000

5 000

19 20 21 22 23

30 29 28 27 26

31 32 33 34 35

Patterson

HUNT CEMETERY

ST LOUIS

SAN FRANCISCO

Patterson Lake

STAR CEMETERY

West Lake

Greenfield Lake

intermittent

water

RENO COUNTY

SEDGWICK COUNTY

455 000 FEET

2 235 000 FEET

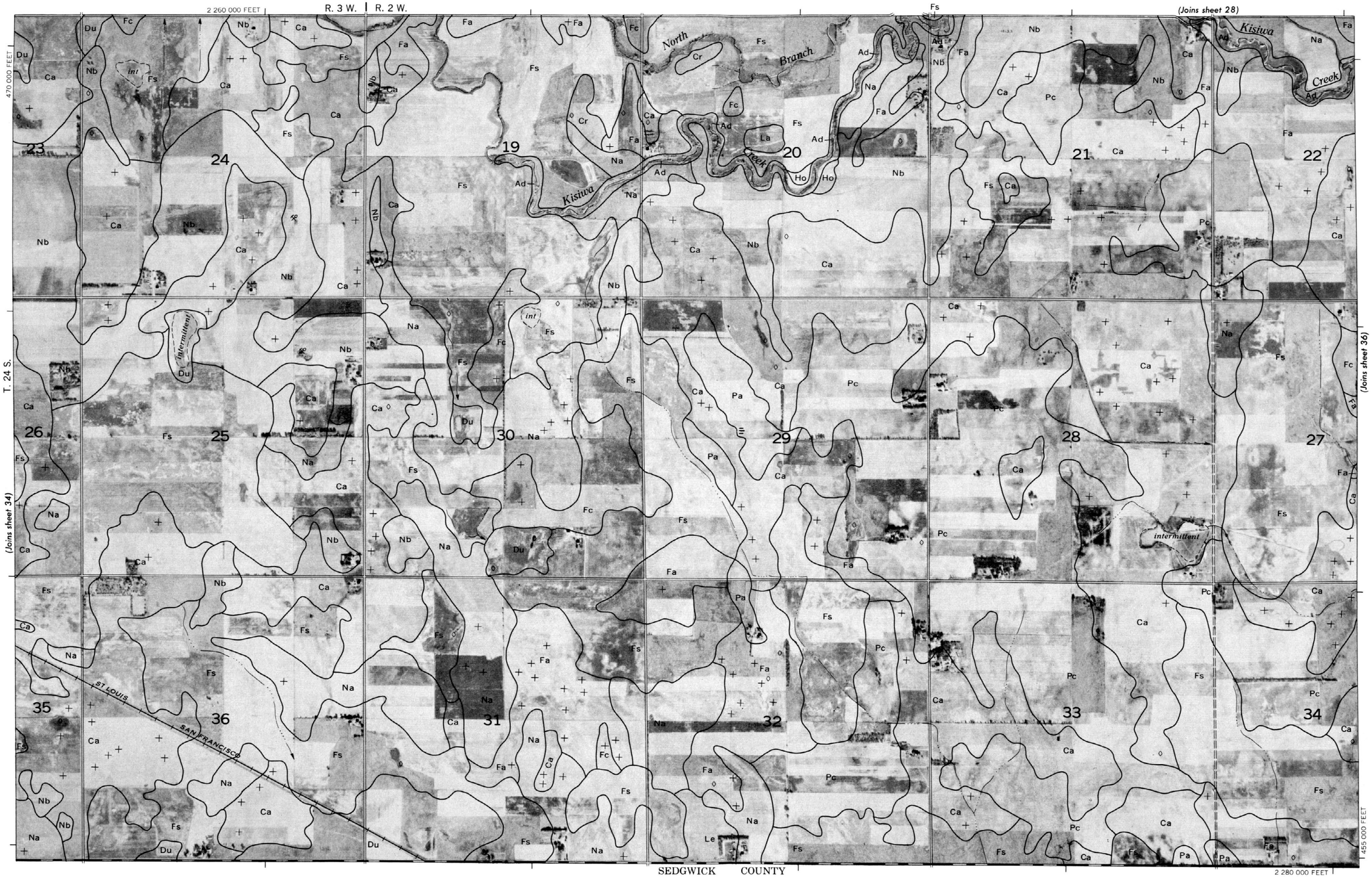
(Joins sheet 35)

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS — SHEET NUMBER 35



35

N

1 Mile

5 000 Feet

Scale 1:20 000

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

N

(Joins sheet 29)

R. 2 W. | R. 1 W.

2 305 000 FEET

470 000 FEET

T. 24 S.

(Joins sheet 35)

455 000 FEET

2 285 000 FEET

SEDGWICK COUNTY

(Joins sheet 37)

Scale 1:20 000

1 Mile 0 5 000 Feet

¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS — SHEET NUMBER 37

37

N

R. 1 W. | R. 1 E.

(Joins sheet 30)

2 310 000 FEET

470 000 FEET

T. 24 S.

(Joins sheet 36)

(Joins sheet 38)

460 000 FEET

2 330 000 FEET

SEDGWICK COUNTY

Sedgwick

HILLSIDE CEMETERY

Arkansas River

Little Arkansas River

Sand Creek

Sand Creek

ATCHISON TOPEKA AND SANTA FE

1 Mile

5000 Feet

Scale 1:20 000

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.
HARVEY COUNTY, KANSAS NO. 37

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

N

(Joins sheet 31)

R. 1 E.

2 355 000 FEET

470 000 FEET

T. 24 S.

(Joins sheet 37)

460 000 FEET

2 335 000 FEET

SEDGWICK COUNTY

(Joins sheet 39)

1 Mile

5 000 Feet

Scale 1:20 000

0 0 ¼ 1 000 ½ 2 000 ¾ 3 000 1 4 000 5 000

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

HARVEY COUNTY, KANSAS NO. 39
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

(Joins sheet 38)

R. 1 E. | R. 2 E.

T. 24 S.

2 360 000 FEET

470 000 FEET

(Joins sheet 32)

(Joins inset, sheet 33)

460 000 FEET

2 380 000 FEET

SEDGWICK COUNTY

Wildcat Creek

West Wildcat Creek

Gypsum Creek

CHICAGO, ROCK ISLAND AND PACIFIC

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

N

1 Mile

5 000 Feet

Scale 1:20 000